CHAPTER 4. SPECIFIC MAINTENANCE OPERATIONS

Section 1. MAINTENANCE OF TRACK

4-1. Lining Track.

Track is aligned at the same time it is surfaced. The "line" rail is always aligned and surfaced first, then the second rail. The line rail is the north or east rail.

4-1.1. Horizontal Alignment. Existing systems, not conforming to grade and curvature standards, may be maintained as is, provided a record is on file describing each deviation from the standard and necessary operating restrictions are imposed. Restrictions shall be tailored to each specific situation and may include such items as maximum speed, use of push bars, and maximum car/engine combination. To assist cars or cranes in tracking and to reduce wear on sharp or substandard curves, it is suggested that tracks be oiled. Track oilers may be installed on Government-owned locomotives operating over sharp curvatures.

4-1.1.1. Railroad trackage. All curves shall have a designated degree of curvature. Curves with radii less than 300 feet or frogs No. 4 and below shall be approved by higher authority than the installation. The radius established by the activity is the base line, design, theoretical radius, or the radius that best fits the overall existing condition. Curve alignment that deviates from established uniformity more than the amount shown in Appendix B is considered defective. Spirals, as designed or as developed, shall have a smooth transition.

4-1.1.2. Ground-Level Crane Trackage. Horizontal rail alignment of curved crane trackage shall be designed or laid out based on analyzing portal crane float requirements for traversing curved track. This analysis of required float can be compared to the float capabilities of all cranes to clearly define the problem areas. The problems may result in limited restriction of crane operation, reworking the running gear on the crane, or realigning the trackage. It should be noted that the available design float of a crane may not necessarily be operational. Curved crane trackage cannot be checked or lined using the string-line method described herein.

4-1.2. Tangents. On tangent track, the line rail is brought to correct line by eye (Figure 4-1) or by use of a transit. The other rail is brought to line by correcting to proper gage. Figure 4-2 illustrates lining track operations.

4-1.3. Curves. Lining of track on curves is more complicated because the curve must not only be uniform throughout its length, but, in most cases, an easement (spiral) into the curve must be provided from both tangents.

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4-1.3.1. Compound or reverse curves should be provided with easements or spirals fom one curve into the other.

4-1.3.2. A transit is employed and curves are staked out in laying out new work or in making major changes to an existing track layout. A transit should be used in laying out new work or when making major changes to an existing track layout. The string-line method can also be used, but is not recommended for new work or major changes. String lining is best used for determining the degree of curvature and in locating and correcting irregularities in the alignment of curves. Field operations and methods of calculation are as given in the AREA manual and Appendix F.

4-2. Surfacing Track.

4-2.1. General. All tracks shall be laid and maintained to correct surface elevation. Surfacing out-of-face refers to raising the track structure to a new grade. Spot surfacing refers to raising low spots to the original uniform surface. Correct surfacing implies that a plane across the top of the rails at right angles to the rails is level on tangents and has the correct inclination on curves when superelevation (para D-2, Appendix D) is used. The track level is used in all surfacing work (Figure 4-3).

4-2.1.1. Pay special attention to surface and line of track at ends and approaches to bridges, trestles, and culverts; through turnouts and crossings; and at platforms.

Figure 4-1. "Eyeballing" track.

Figure 4-2. Operation of lining track.

4-2.1.2. Work against the current of traffic when raising track, except on heavy grades where it is desirable to work upgrade.

4-2.1.3. Before raising track during hot weather, be sure that rails will not warp or buckle. Consider the amount of rail openings at joints, tightness of bolts, position of rail anchors, and amount of ballast in cribs and at ends of ties. Where there is danger of buckling, loosen track joints in both directions from the danger point to allow for expansion.

4-2.1.4. In bonded-track territory, see that ballast clears the base of the rail to prevent leakage of current. Separate ballast and base of rail by a space of about 2 inches.

4-2.2. Grade. Profile grades shall not exceed the design grade except as noted below.

4-2.2.1. Railroad Trackage. Grades may be spot checked at random intervals with a hand level and rule. All grade changes shall be connected with a vertical curve. Switches may be installed on grade; however, no part of the switch should extend into a vertical curve.

4-2.2.2. Ground-Level Crane Trackage. On existing trackage with grades in excess of 1 percent, if cranes do not encounter acceleration or deceleration problems in traversing the tracks, no action is required. However, if problems are apparent or if other deficiencies dictate complete replacement of the track, the criteria of 1 percent maximum grade shall be followed. Curves, switches, and frogs shall be on a level grade in order to minimize the possibility of derailment. NOTE: If existing grade is not level or if there is a difference in elevation of 1 inch between the inside rail and the outside rail, crane float shall be analyzed to determine whether the wheel flanges will clear the rail and permit the truck assembly to swivel and cause derailment. Observing the position of the wheel flanges in relation to the top of the rail will reveal areas that may become critical. If wheel flanges clear the top of the rail, extreme caution must be taken during operations and immediate action initiated to correct the deficiency. The area in question should be classified as critical and well marked so that all crane operators and crews will be cognizant of the deficiency.

4-2.2.3. Elevated Crane Trackage. The rail should be kept near level grade. The rail gradient must be kept below the slope that will cause the crane to roll freely and present problems in starting or stopping the crane.

Figure 4-3. Surfacing track with a leveling beam.

4–2.3. Cross-Section Elevation. Vertical differences between rails shall be within the limits shown in Appendix B.

4–2.3.1. Railroad Trackage. On curved trackage with designed superelevation, the outside rail shall not be lower than the inside rail and the maximum cross-section elevation differences shall be within the limits shown in Appendix D for the designed superelevation based on degree of curvture and speed. On curved trackage in industrial areas traversed at low speeds, superelevation is not required.

4–2.3.2. Ground-Level Crane Trackage. When the difference in elevation between the elevation of the inside rail and the outside rail exceeds 1 inch, the crane float shall be analyzed and appropriate action taken.

4–2.3.3. Elevated Crane Trackage. The cross-sectional difference in elevation of rails shall not exceed the limits established by the activity based on engineering judgement for each specific trackage system or the tolerance recommended by the manufacturer when known.

4–2.4. Hand Jacking. There are two methods of surfacing track with track jacks: one is used where the lift is less than 2 inches, and the other where the lift is more than 2 inches. The two methods are discussed below:

4–2.4.1. In starting a raise or lift of less than 2 inches, jacking points should be spaced 8 to 12 feet apart. Place the first jack approximately 10 feet ahead of starting point of the raise. Place the second jack 10 feet ahead of the first jack. Raise both jacks to give an even grade from the starting point to the second jack. Tamp the ties to a point approximately halfway between the jacks. Bring the other rail to proper surface with the aid of the track level. Then move the first jack about 10 feet ahead of the second, raise the rail at that point, and tamp the ties halfway between the jacks. Follow the same procedure to bring the other rail to proper surface, using the track level to determine the amount of lift.

4–2.4.2. To lift the track more than 2 inches, locate both jacks as above, but reduce the spacing between jacks to avoid permanent bending of the rail. Raise the first jack to bring the rail to grade between 0 and 1. Then raise the second jack enough to provide reasonable runoff between the new grade and the low spot. Tamp ties to a point approximately one-fourth the distance between 1 and 2. Raise the second jack to bring the rail to proper grade, and move the first jack ahead the proper spacing. Tamp as before, and continue the same operations through the full length of track to be raised.

CAUTION: In both methods, jacks must be placed ahead of rail joints to prevent strain on joint bars (Figure 4–4).

4–2.4.3. In raising or surfacing track, the inner rail on curves and the line rail on tangents are the grade rails. Bring them to surface with the aid of the spot board, or refer them to grade stakes. Bring the second rail to surface with the aid of the track level.

4–2.4.4. Bring both rails to grade, tamp ties, set tie plates, gage track, and drive spikes fully before jacks are moved ahead.

4–2.4.5. Place track jacks in cribs between the ties outside the rail, and set them true vertically. If jacks are to be placed between rails, set them in trip position, and provide flag protection.

4–3. Tamping.

Systematic and uniform tamping is of great importance in maintaining correct surface and line. See Figures 3–7 through 3–9 and paragraph 3–6.3.

4–3.1. Tools. Pneumatic, electric, gasoline, or other mechanically operated or hand tampers may be used for tamping. The type of tool varies somewhat for different materials as follows:

4–3.1.1. For broken stone, crushed and washed gravel, or slag ballast, use a tamping pick or bar, ballast spade, or power tamper. Power equipment will be fitted with a tool having an end similar to a tamping pick face or vibratory tool.

4–3.1.2. For gravel, chats, or chert ballast use a shovel, ballast fork, ballast spade, tamping pick, tamping bar, or power tamper. For heavy traffic, a tamping pick, tamping bar, or power tamper should be used. With a power tamper use a tamping tool with a tamping end of sufficient area. For light traffic, shovel tamping is sufficient.

4–3.1.3. For spot tamping, tamping picks, ballast forks, ballast spades, shovels, tamping bars, or power tampers may be used.

4–3.2. Methods. After the track has been raised on jacks to a true surface, pack ballast firmly under the ties. Tamp so that a tight bearing is obtained between the tie and the raised rail, but without disturbing the surface. The following tamping methods apply:

4–3.2.1. Tool Positioning. Regardless of the kind of ballast or the kind of power tamper used, two tamping tools must always be worked opposite each other on the same tie. Start power tampers from a vertical position, and use them directly against the sides of the tie to be tamped. Work downward past the bottom corner, after which the tools may be tipped down to force the ballast directly under the tie.

4–3.2.2. Tamping Distances. In tamping ties, 8-foot crossties should be tamped from 12 inches inside the rail to the end of the tie, 8-foot 6-inch crossties should be tamped from 15 inches inside the rail to the end of the tie, and 9-foot crossties should be tamped from 18 inches inside of the rail to the end of the tie.

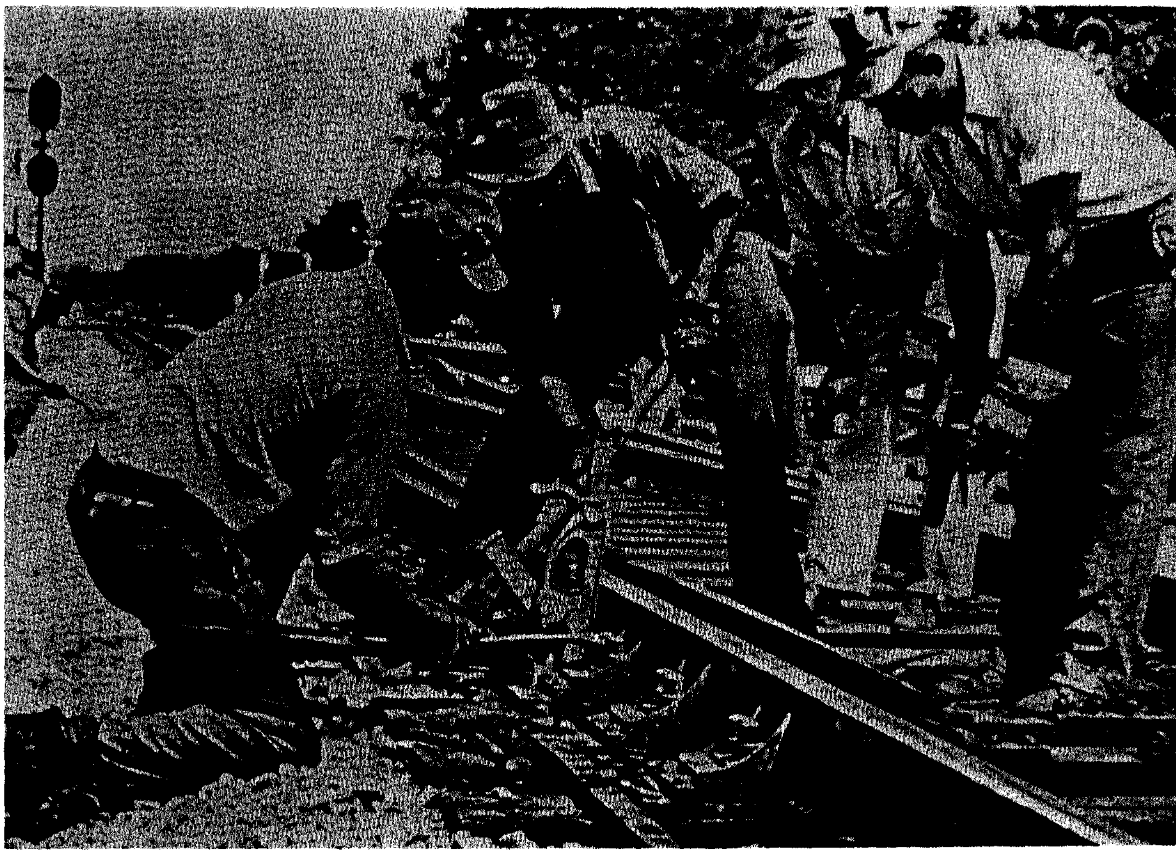


Figure 4-4. Jacking rail.

4-3.2.3. Cautions. Omit tamping at the center of the tie, between the above stated tamping limits, but this center area should be filled lightly with a ballast fork. Both sides of the ties must be tamped simultaneously, and tamping inside and outside the rail should be done at the same time.

4-4. Gauge Measurements.

Check gage of track at least annually and more frequently when the volume of traffic or local conditions warrant. Gage for railroad trackage is measured between the heads of the rails at right angles to the rails in a plane 5/8 inch below the top of the railhead. Gage for crane trackage is measured center to center of railhead.

4-4.1. Railroad Trackage..

4-4.1.1. Tangent Tracks and Curves. The standard gage of 4 feet 8-1/2 inches is used for tangent track and on curves up to 8 degrees (Figure 4-5). On curves over 8 degrees, the gage is increased 1/8 inch for each increment of 2 degrees to a maximum of 4 feet 9-1/2 inches, by moving the inside roll. The rate of change from standard to widened gage is 1/4 inch in 31 feet along the spiral curve or tangent adjacent to the curve, unless physical conditions do not permit the normal transition. The 1/4 inch in 31 feet rate of change from standard gage to widened gage for curves is a design standard and not trackage inspection criteria.

4-4.1.2. Turnouts and Crossovers. At turnouts and crossovers on curved track, the gage of the parent track is determined from the degree of curve, as described above. The degree of the turnout curve is determined by the algebraic sum of the two curves, i.e., curve of the turnout plus or minus the curve of the main track (para 3-31.4.), and the gage adjustment is made accordingly.

4-4.1.3. Ground-Level Crane Trackage. The gage on curved trackage shall under no circumstances require more lateral float than the crane can provide.

4-4.1.4. Elevated Crane Trackage. The gage of trackage shall be held within the tolerances specified by the crane manufacturer or as computed from the existing crane wheel spacing.

4-4.2. Limiting Factors for Corrective Maintenance. Variations in gage within the limits shown in Appendix B are acceptable, provided there are no alignment, attachment, or foundation defects which

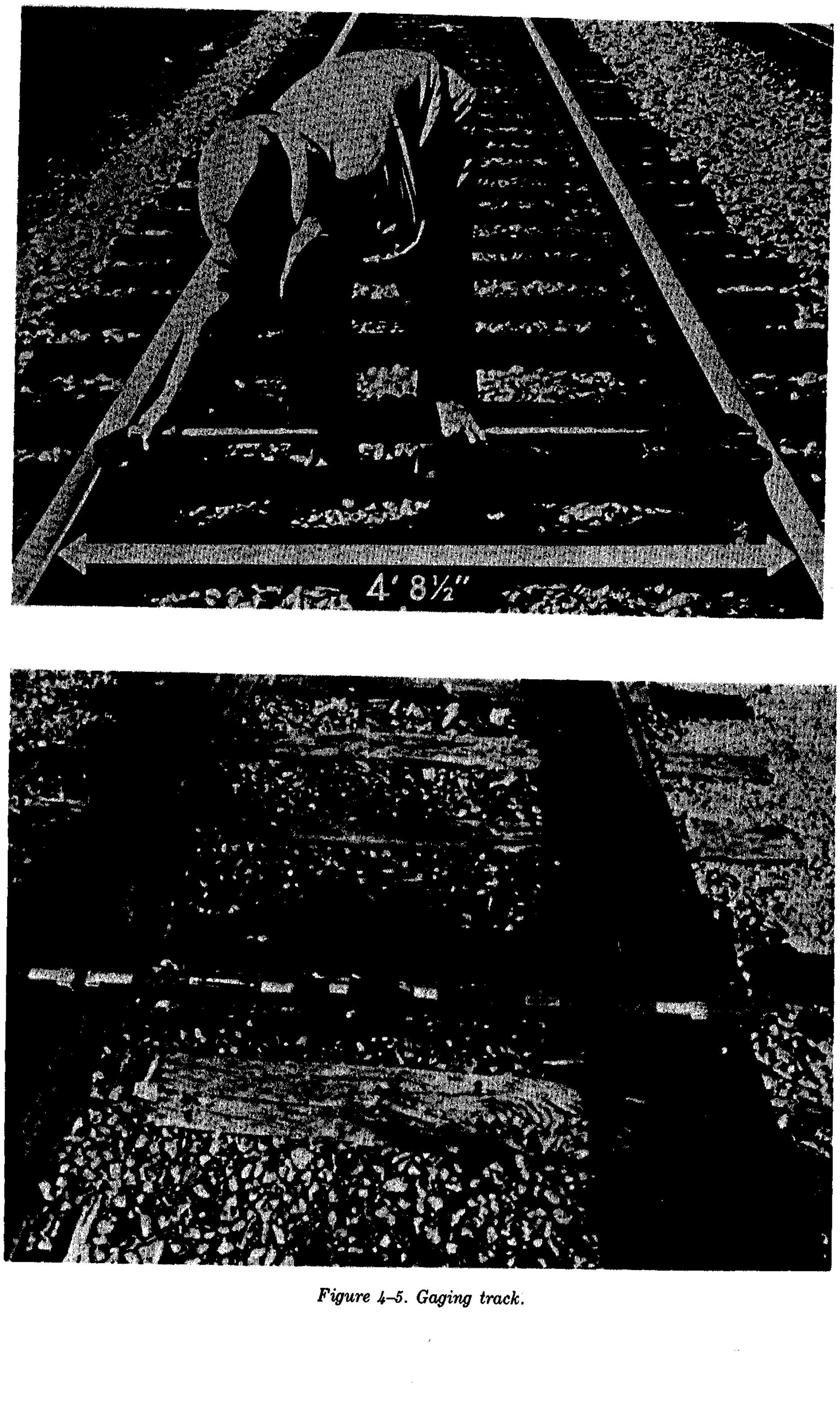


Figure 4-5. Gaging track.

would cause the train to start excessive or abnormal rocking or bouncing. Variations in gage and wide gage transitions are not serious provided the changes are relatively uniform and constant over two standard rail lengths, the fastenings secure, and the alignment within prescribed limits. Wide gage, caused by worn rail should be corrected by closing in or by interchanging the low and high rails.

CAUTION: Interchanging the low and high rails can cause failure due to the change in stress location.

4–4.3. Procedure for Regaging. The standard track gage is used in correcting gage. It will be checked frequently and replaced when it shows a variation of 1/8 inch or more. All spike pulling and driving is done on the rail opposite the line rail. The gage is not removed until all spikes have been driven. Spikes are pulled with the standard claw bar (Figure 4–6) or spike puller (Figure 4–7). At switches, frogs, and guardrails, where the claw bar will not fit between rails, the spike puller extension is used. Creosote-treated tie plugs are driven in all spike holes before respiking. Corrections to gage shall not be made by striking the head of the driven spike toward the rail. Spikes shall be removed, rail lined to gage, and spikes redriven.

4–5. Spiking.

Spiking will follow the standards set forth in paragraph 3–21, steps h through k.

4–6. Rules for Turnout Installation.

See paragraphs 2–2 and 3–31 for general discussion and Figures 2–1 through 2–14 for descriptions. Turnouts, crossovers, and their appliances are placed and maintained in accordance with standard plans and the following rules:

4–6.1. Locate point of frog and point of switch.

4–6.2. Relocate any main-track rail joints that come within the limits of switch point or guardrail.

4–6.3. Cut the lead rails, bearing in mind that the turnout lead is longer than the main-track lead.

4–6.4. First, put in headblocks and gage plate or two side plates, then all ties for the switch point and frog, and their slide plates, braces, heel plates, and guardrail plates. The plates and braces for the unbroken line or rail are lined and fully spiked in position, whereas those on the turnout side are held in place temporarily.

4–6.5. Bend a rail for the turnout stock rail according to the data shown in Table 3–3, paragraph3–31.7.d.

4–6.6. Couple the stock rail, main-track switch point (heel block to be placed later, if used), lead rails, and frog, on the ends of ties on the turnout side, doing such cutting and drilling as may be necessary to complete the main track from the point of the switch to the heel of the frog.

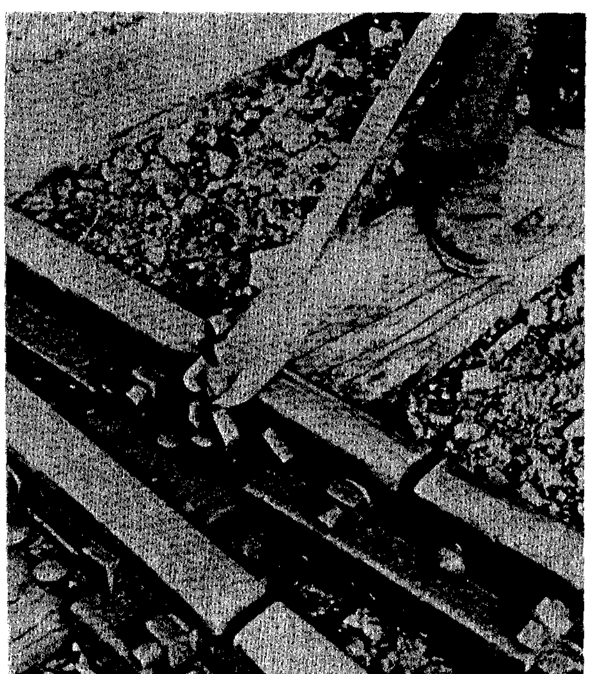


Figure 4–6. Pulling spikes with a claw bar and extension.

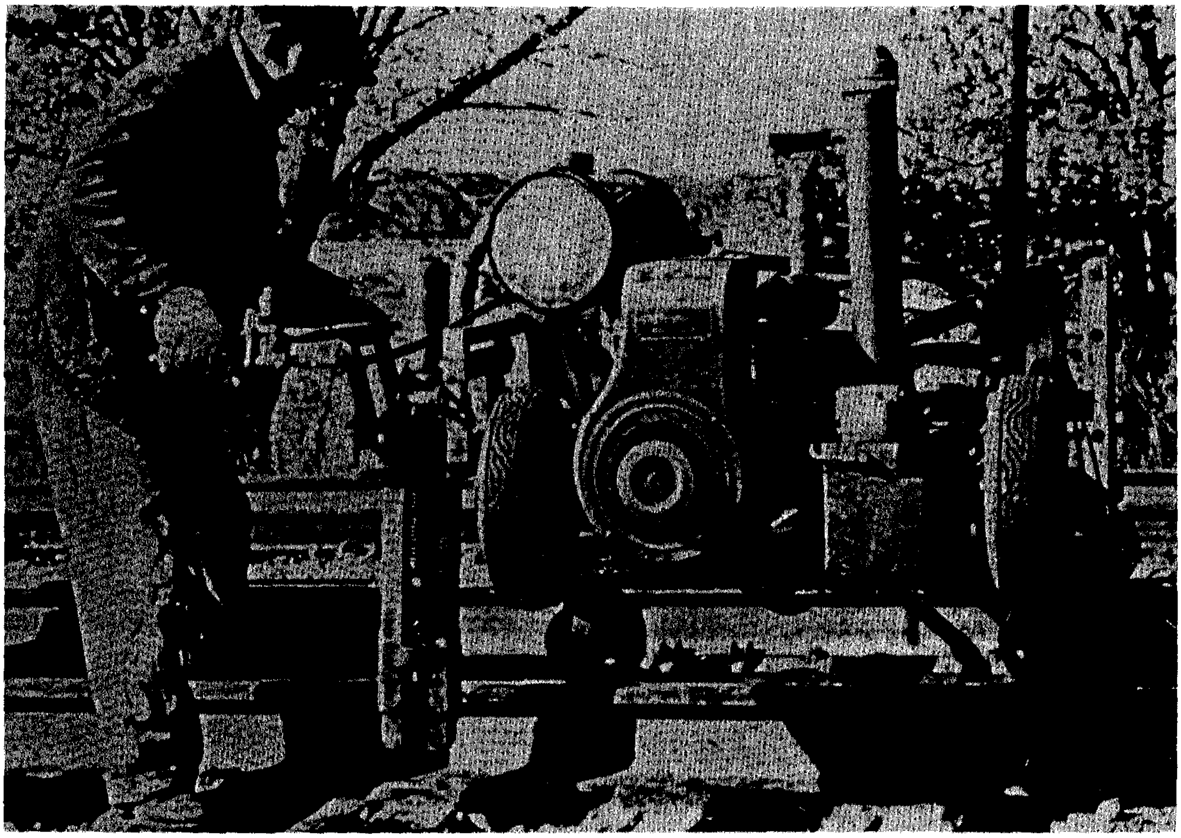


Figure 4-7. Power operated spike puller.

4-6.7. Take out the old main-track rail; set in the turnout parts in the following order: (1) place stock rail and switch point, (2) place the lead rail and frog, (3) make connections at the heel of the frog and at the stock rail, (4) spike frog to exact gage at the heel and the toe point, (5) place joint bars and tighten bolts, and (6) complete spiking from the frog to the heel of the switch point.

4-6.8. Do not permit train movement over main track until the guardrail has been correctly placed and spiked, all switch plates on the turnout side have been fully spiked in correct position, the switch point has been spiked against the stock rail, and the free end of the stock rail fastened to prevent movement.

4-6.9. In applying the switch plates on the turnout side: (1) see that gage is correct 12 inches ahead of switch point, and (2) put slide plates on tie where switch point begins to taper.

4-6.10. Adjust stock rail so that it does not bind against switch point and cause it to open. (To test this, operate the switch point and see that point touches the stock rail first.) Spike these slide plates, Install and spike remaining slide plates and braces, working each way from the center.

4-6.11. When putting on slide plates, use a bar (not a pick), and do not attempt to draw the gage with a spike.

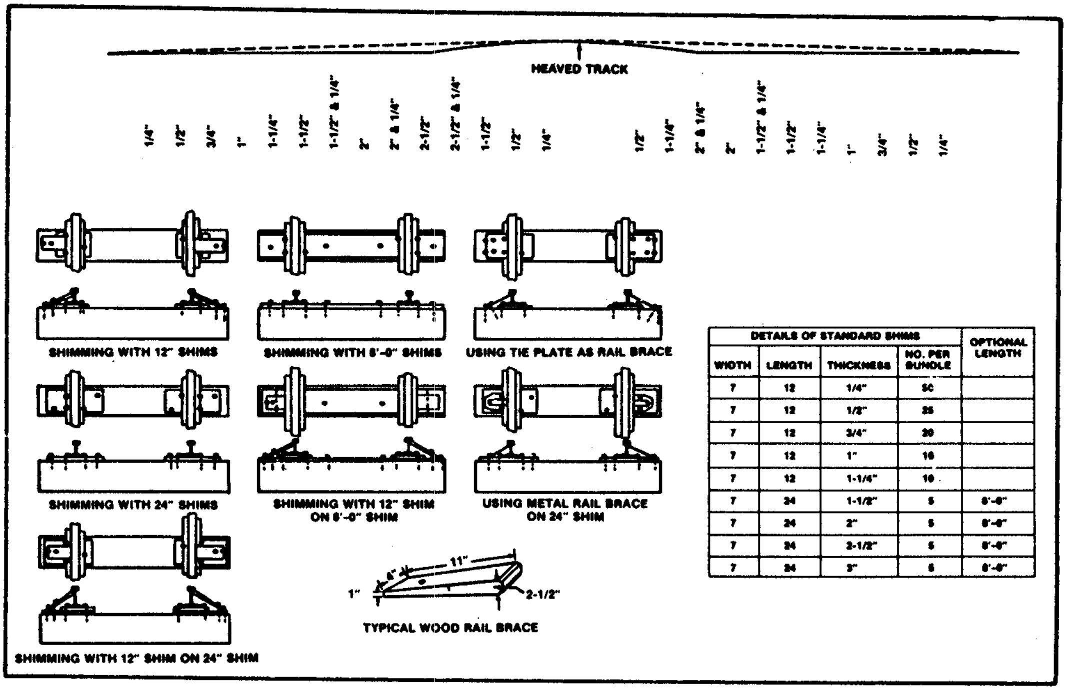
4-6.12. Put in the remaining switch ties, and line and surface main track.

4-6.13. Couple switch point for the turnout lead, set lead rails, and spike turnout lead to proper line for turnout curve.

4-6.14. Complete the work by setting the remaining guardrail (and switch-point guardrail if staggered switch points are installed), setting and adjusting the switch-operating mechanism, checking the line, gagging, spiking, and surfacing.

4-7. Shimming Track.

4-7.1. General. Heaving of track in winter and spring months is generally an indication of poor drainage or poor ballast conditions, which must be corrected as soon as frost leaves the ground. Until the cause can be eliminated, heaving can be corrected temporarily by using shims to raise the rails on either side of the high spot, thus providing an easy grade (Figure 4-8). The length of this temporary raise is



DETAILS OF STANDARD SHIMS				OPTIONAL LENGTH
WIDTH	LENGTH	THICKNESS	NO. PER BUNDLE	
7	12	1/4"	50	
7	12	1/2"	25	
7	12	3/4"	20	
7	12	1"	10	
7	12	1-1/4"	10	
7	24	1-1/2"	5	3'-6"
7	24	2"	5	3'-6"
7	24	2-1/2"	5	3'-6"
7	24	3"	5	3'-6"

Figure 4–8. Application of wood shims and rail braces in shimming track.

called the runoff. *NOTE:* Criteria for maximum runoff are contained in Appendix B.

4–7.2. Methods. When shimming is necessary, it will be done so as to provide easy and safe runoff gradients. When one side of the track is heaved more than the other, proper cross level will be restored when shims are installed; care must be taken on curves to maintain proper curve elevation. Heaved ties will not be adzed or otherwise cut to lower their height; shimming under ties is prohibited except in an emergency, in which case the shims shall be removed, and the condition otherwise taken care of as soon as possible.

4–7.3. Rules for Shimming and Bracing. When installing shims, the track level and gage will be used to insure proper gage and surface.

4–7.3.1. Before a shim is placed on a tie, all spike holes in that tie must be plugged with treated wood tie plugs, the tie shall be free of ice, snow, and other obstructions within the area of the shim, and full bea ring of the shim on the tie shall be provided.

4–7.3.2. Two shims of the same length will not be used together under one rail on a tie. One 12-inch shim may be used on top of a 24-inch or on top of a 3-foot 6-inch shim. One 24-inch shim may be used on top of a 3-foot 6-inch shim. One 24-inch shim may be used on top of a 24-inch shim that has been placed on top of a 3-foot 6-inch shim. Where possible, use only one shim. Where two shims are required, the lower shim must be of maximum thickness. Where three shims are required, the two lower shims shall each be of maximum thickness.

4–7.3.3. When tie plates with special shallow base patterns or with shallow ribs on their bases are in use, they should be installed on top of shims. When tie plates with deep ribs on their bases are in use, they should not be installed on top of shims. Shims shall never be installed on top of tie plates.

4–7.3.4. In all cases where a 12- or 24-inch shim, or a 12-inch on top of a 24-inch shim, is installed, all spikes used shall be long enough to provide a minimum penetration of 4 inches in the tie. In all cases where a 3-foot 6-inch shim is installed, it will be properly and independently spiked to the tie with 7–1/2-inch shimming spikes. In all cases where a 12- or 24-inch shim is installed on top of a 3-foot 6-inch shim, all spikes through the shorter shims shall be long enough to go through the 3-foot 6-inch shim and have a minimum penetration of 1 inch in the tie.

4–7.4. Precautions.

4–7.4.1. Driving shims at an angle between the spikes weakens the track and is prohibited. Shims shall be placed squarely on top of the tie and the spikes driven through the holes provided.

4-7.4.2. Wood or other types of rail braces should not be used where shimming is done on tangent track or on curved track equipped with shoulder tie plates of a type that is to be used on top of shims. Where shimming is done on curved track not yet equipped with tie plates, or equipped with shoulder tie plates of a type that will not be used on top of shims, wood or other approved rail braces shall be installed with the shims.

4-7.5. Reestablishing Normal Surface. As the frost leaves the ground and the heaved places return to their proper level, the shimming may be reduced from time to time in order to maintain proper surface. When the frost has left the ground, all shims shall be removed without delay from the track and any imperfect surface corrected. Removed shims and shimming spikes should be carefully preserved for future use.

Section 2. MAINTENANCE OF TRACK IN STREET CROSSINGS AND IN PAVED AREAS

4-8. General.

Prompt attention must be given to correcting deficiencies as they occur at crossings and around tracks in paved areas. The maintenance of the track bed and trackage will be the same as that outlined in the foregoing chapters and sections, except that inspection will be more difficult and additional maintenance is required for the paving, planking, etc., to insure smooth and safe operation of vehicles in the area. Because track maintenance in paved areas is more costly and time consuming, materials supporting and contained in the track structure must have as low a maintenance potential as possible. For that reason, materials that will resist deterioration and changes in grade and gage are recommended.

4-9. Drainage.

Drainage is critical. It can present more problems at crossings than at other points on a railroad. Catch-basins, gutters, ditches, pipe drains, and/or culverts, as appropriate, must be provided to intercept and divert both surface and subsurface water at depressed or downhill crossings. Base materials underlying tracks and pavement must be of appropriate, well-graded, granular materials; pavement surfaces must be adequately crowned and sloped to direct water into the catch-basins and ditches. Additional information on drainage is included in Section 3 of this chapter.

4-10. Ballast.

Ballast under a properly maintained pavement or crossing normally requires little or no maintenance. However, if the ballast is not installed properly on a good foundation in the beginning, or if the surface over the ballast permits infiltration of water, silt, and other debris, the ballast can become fouled and interfere with the drainage. If the track through the crossing is not well ballasted, or if the ballast is fouled, the ballast and subballast should be removed not less than 2 feet below the bottom of the ties, not less than 2 feet beyond the ends of the ties, and to the first rail joint away from the crossing and replaced in accordance with criteria set forth in Chapter 3, Section 2.

4-11. Ties.

The condition of crossties under crossings or pavement cannot be determined without removing the crossing materials or paving. If untreated ties were originally installed, they may be seriously damaged by insect attack or decay in a short period of time (Figure 4-9). The first indication of tie failure may be settling of the rails or paving or a change in track gage. When tracks are torn up to replace the ties, it not only interferes with train operations, but also with the use of the area or crossing by vehicular traffic. When the trackage has been uncovered for repairs, the whole trackage system in the crossing or paved area should be brought up to proper condition. Drainage and ballast should be investigated and replaced or restored before the new ties are installed. Also, all the ties should be replaced at this time. Normally, 9-foot treated wood ties are used through the limits of a crossing. However, concrete ties should be considered when replacement is needed because they require little or no maintenance and hold the track in gage.

4-12. Rail.

As a general rule, bolted rail joints are not allowed within a crossing. Where crossing widths and rail lengths are such that joints have to be included, they shall be properly welded. The nearest bolted joints should be at a minumum of 6 feet outside of the crossings. Every precaution must be taken to insure adequate and continuing bonding of rail through the crossing. All rail and metal fittings used within a crossing shall be given a coating of an approved rust inhibitor. Rail shall be gaged and lined accurately and double spiked to the ties. The ballast under the track shall be solidly tamped to bring the track to grade. If concrete ties are used, the rails will be firmly bolted to the ties and the track then brought to grade.

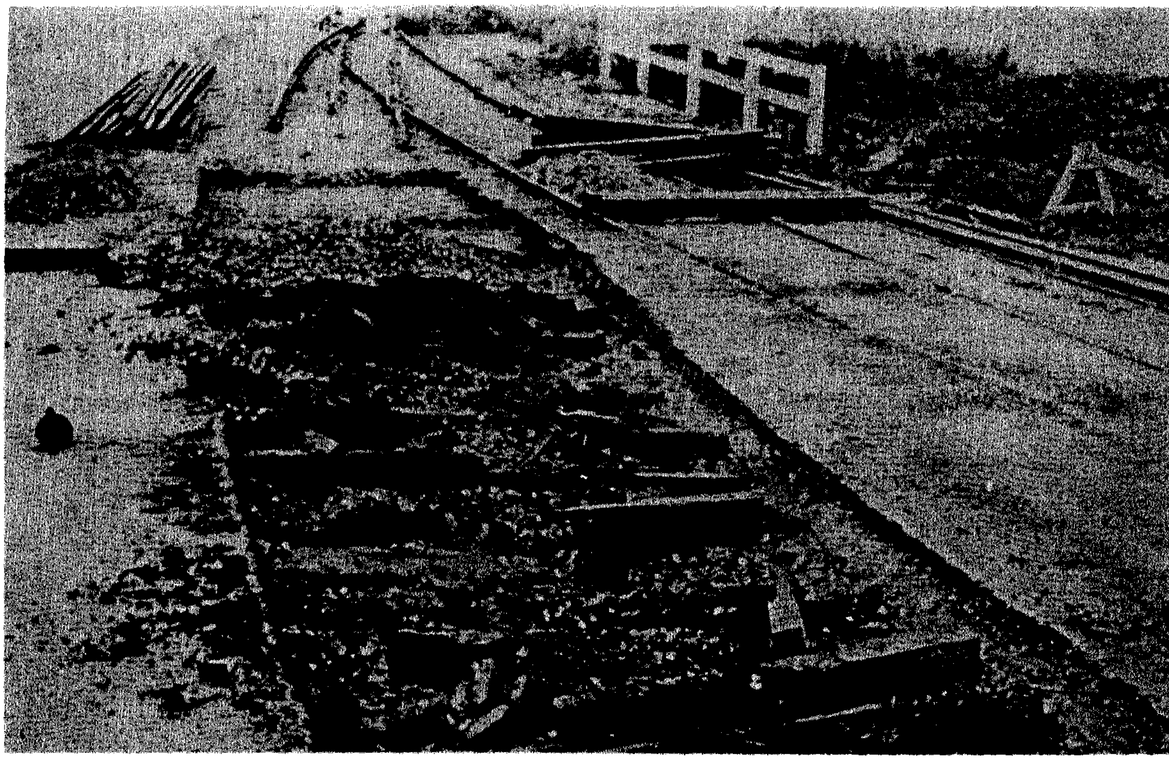


Figure 4-9. Ties decayed under paved area.

4-13. Crossing Surfaces and Materials.

4-13.1. General. Crossing surfaces must be as smooth as possible, and the materials selected for this purpose must be suitable for the type of traffic using the crossing. Although it may be desirable to match the material and texture of approach pavements, consideration must be given to a material and an installation that is economical to maintain and that will have a long service life. Materials such as Portland cement concrete or bituminous concrete are economical to install, but are costly to remove and replace. Wood plank and prefabricated materials may be a little more costly to install, but are removable and reusable and therefore are more economical to use in the long run. Further, because they are easily removed and replaced, they facilitate the inspection of the track. In plank-type crossings, the flangeways are often open down to the ties, which exposes the subgrade and ballast to the water, silt, and debris that flow to this opening. Regardless of the materials used, flangeways must be provided, 2-1/2 inches for tangent and nominally curved track. On curves over 8 degrees, the flangeways must be widened to 2-3/4 inches. Rubber and plastic crossing pads and rubber flangeway fillers are available for some types of crossings and should be installed, especially in areas where small-wheeled vehicles use the crossing.

4-13.2. Street and Highway Crossings. Street or highway crossings should be at least 4 feet wider through the crossings than the width of the approach pavements (Figure 4-10). When the corssing has to be repaired or replaced and the crossing is the same width as the approach pavements, the crossing width should be extended 2 feet on each side. The additional width is necessary to reduce the hazards of vehicles running off the sides of the crossing (Figure 4-10). The most frequently used crossing materials are listed below:

4-13.2.1. Bituminous Concrete. Where traffic is light, the entire crossing may be constructed by bituminous concrete. In very light traffic areas, the flangeways may be formed by running the locomotive wheels through the hot mix after it has been placed and rolled (Figure 4-11). Some finishing may be required to smooth the material that has been shoved out of the flangeway. However, at crossings with a high volume of traffic or heavy truck traffic, a flangeway guard is needed to protect the edges of the asphalt section between the rails. The guard may be constructed of wood (Figure 4-12). Metal flangeway guards may be fabricated from used rail (Figure 4-13) or purchased from commercial sources (Figure 4-14).

4-13.2.2. Portland Cement Concrete. Constructing a crossing with cast-in-place concrete requires closing

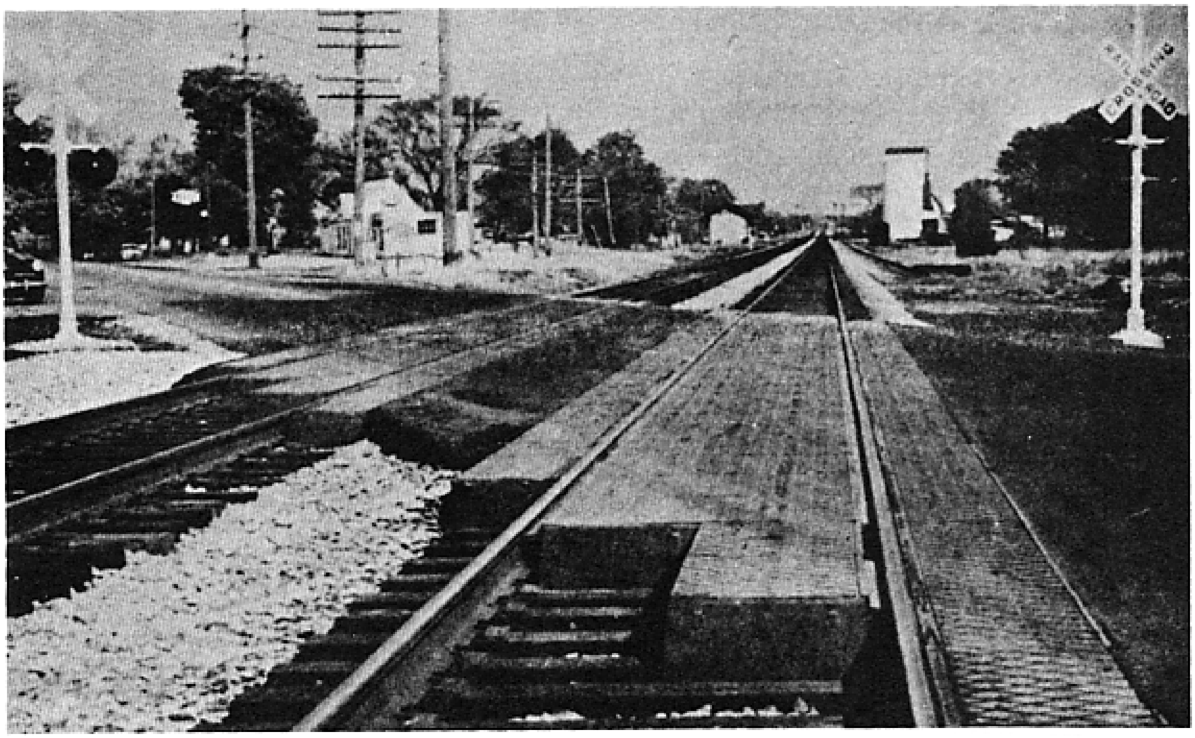


Figure 4-10. Double track crossing.

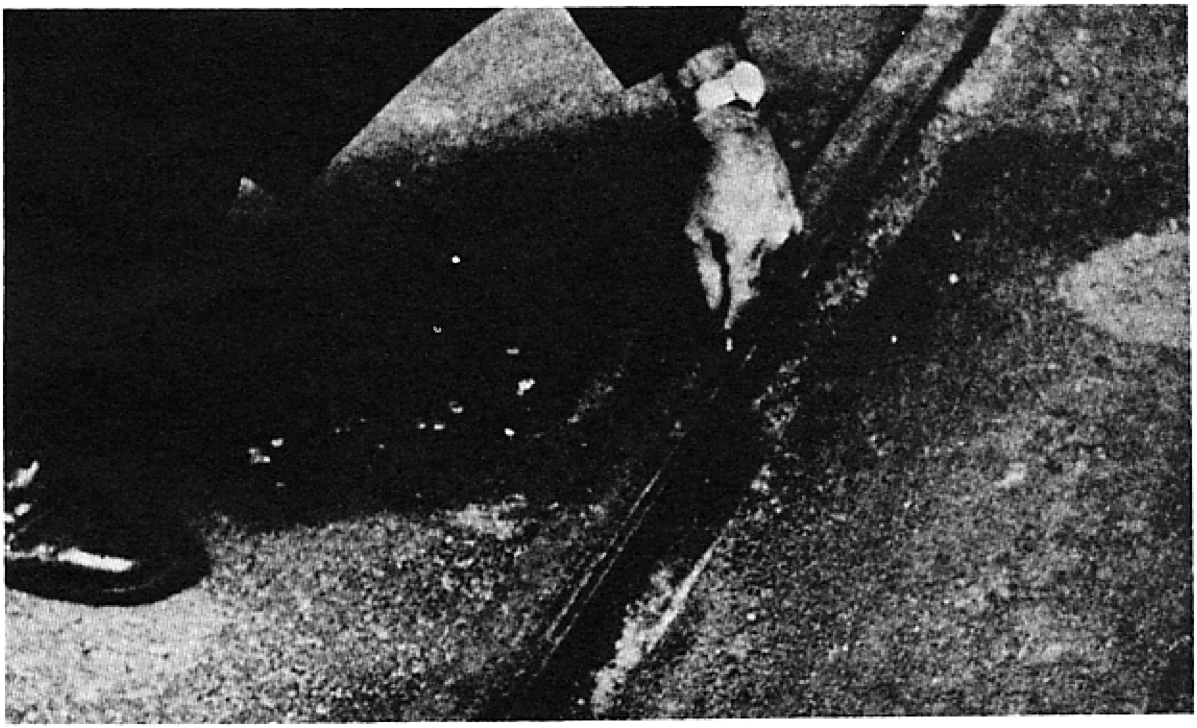
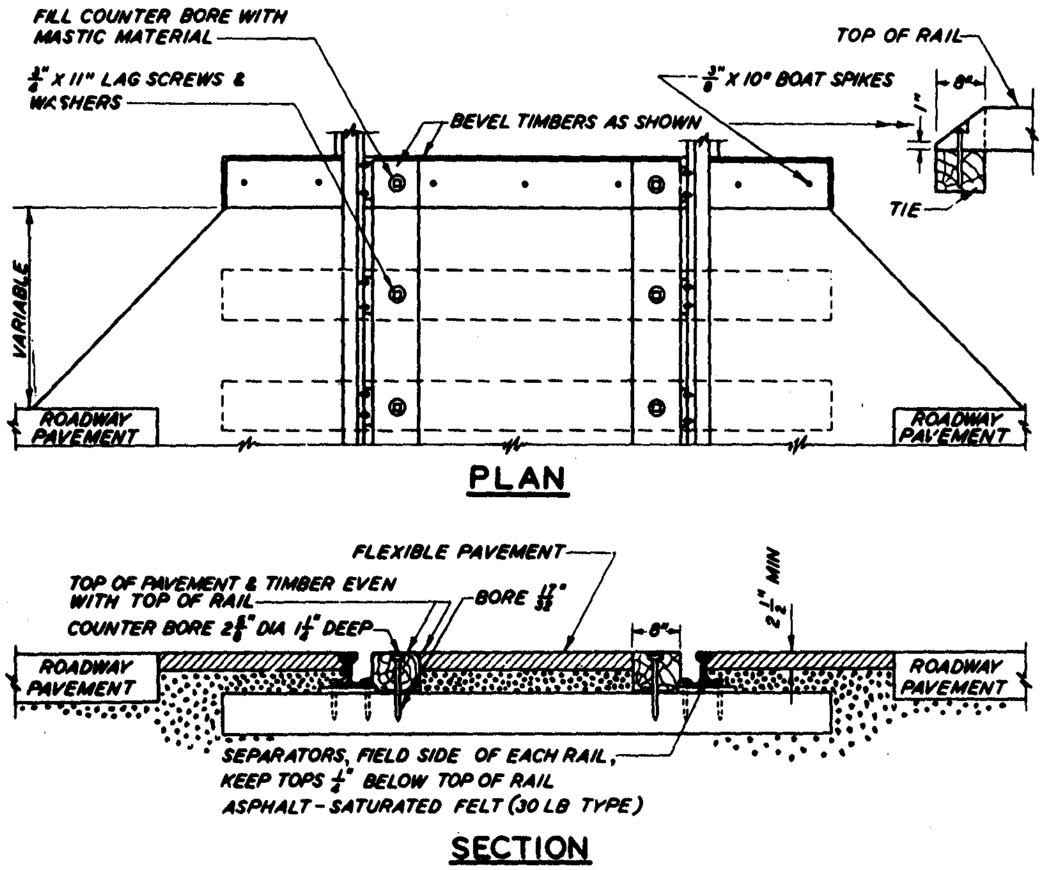


Figure 4-11. Bituminous concrete crossing flangeway made with engine wheels



NOTE: ALL TIES THRU THE CROSSING SHALL BE SAWED FORM A, SIZE 4, AND SPACING SHALL NOT EXCEED 20 INCHES.

Figure 4-12. Bituminous crossing with wood flangeway guard.

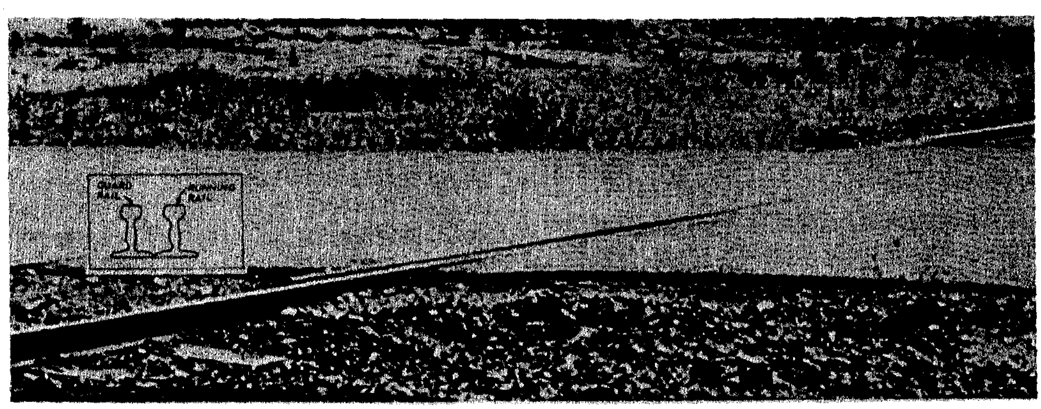


Figure 4-13. Used rail flangeway guard.

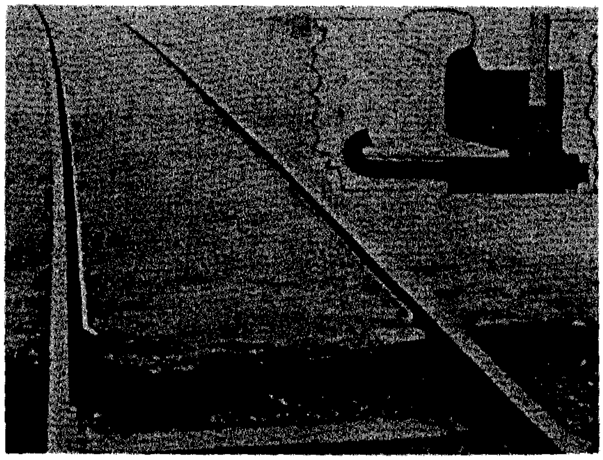


Figure 4-14. Metal flangeway guard.

the crossing or limiting vehicular traffic to one lane during construction and concrete curing. This type of crossing, however, provides a smooth riding and durable surface (Figure 4-15). A poured concrete crossing is costly to remove and replace.

4-13.2.3. Precast Concrete Planks. This type of material provides a long-lasting surface for all volumes of traffic. Several types of Portland cement concrete planks are available on the market for this purpose. Special care must be taken to insure even support throughout the length of each plank. Figure 4-16 gives plan and section views for a typical installation; Figure 4-17 shows a typical installation. Some types of precast concrete crossings are available with rubber fillers for the flangeway (Figure 4-18).

4-13.2.4. Wood Plank Crossings. This type of crossing has been successfully used for many years. Treated timber will last for a long time, but may require retightening of lag screws from time to time as they will become loose as the timbers flex under traffic. A well-maintained wood plank crossing is shown in Figure 4-19.

4-13.2.5. Prefabricated Rubber Planks. Prefabricated rubber planks provide a smooth riding, durable, and maintenace-free crossing. A typical installation is shown in Figure 4-20. This type of crossing, as well as other prefabricated types, is salvageable and can be reused..

4-13.2.6. Modular Plastic Crossings. Modular plastic crossings are durable, smooth riding, and practically maintenance free. The sections are molded and if a section is damaged, it can be replaced without disturbing any other sections (Figure 4-21).
Used rail crossings are slippery when wet and do not afford a smooth ride to small-wheeled vehicles.

4-13.2.7. Used Rail. Crossings have, on occasion, been fabricated from rail that has been worn beyond further use in the track system (Figure 4-22). These rails, which should be the same weight as the running rails, are laid side by side, head up, between and parallel to the running rails with adequate flangeway. Used rail crossings are slippery when wet and do not afford a smooth ride to small-wheeled vehicles.

4-13.2.8. Two-Component Epoxy and Rubber. A poured in place two-component epoxy combined with rubber is available which seals the ballast from intrusion of water. This type crossing is expensive.

4-14. Track in Paved Areas.

The type of vehicular traffic, in particular the size of wheel and type of tire, determines the type of material and construction used adjacent to and between rails in paved industrial areas. Normally, cast-in-place Portland cement concrete or asphaltic concrete pavements are used with flangeway guards appropriate for the vehicular traffic (Figure 4-23). Where small-wheeled, solid-tired vehicles are used, a rubber flangeway filler is recommended. Flangeways may also be formed by the use of girder rail (A in Figure 4-23) through the crossing or pavement, or by placing used rail on its side with the head against the web of the running rails (B in Figure 4-23).

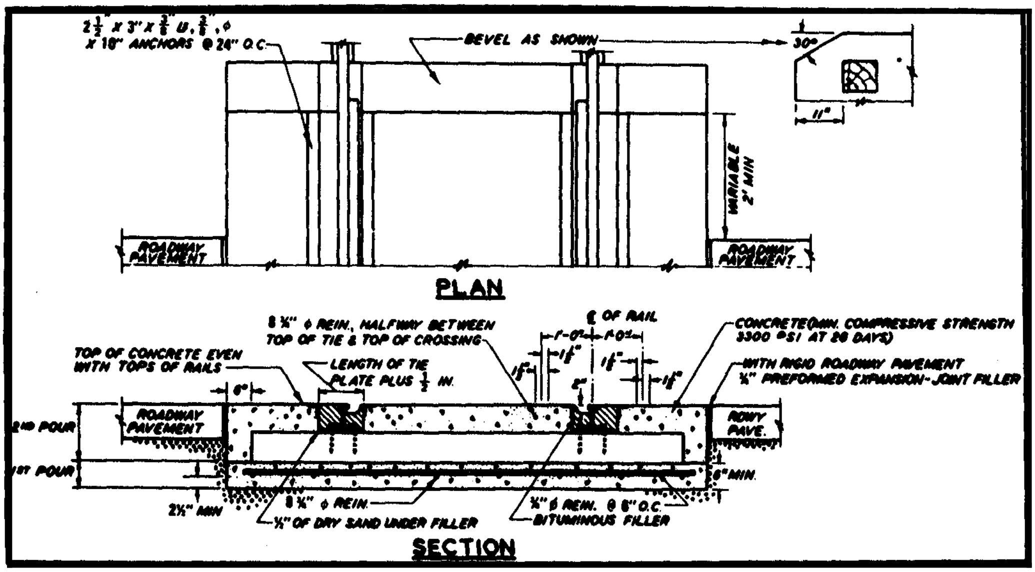


Figure 4-15. Cast-in-place concrete crossing.

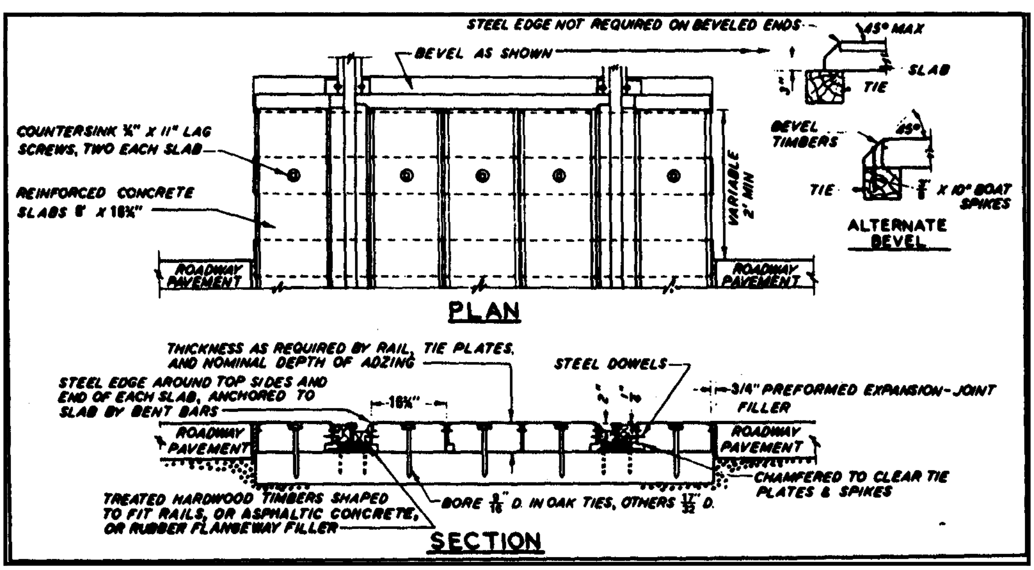


Figure 4-16. Precast concrete slab crossing.

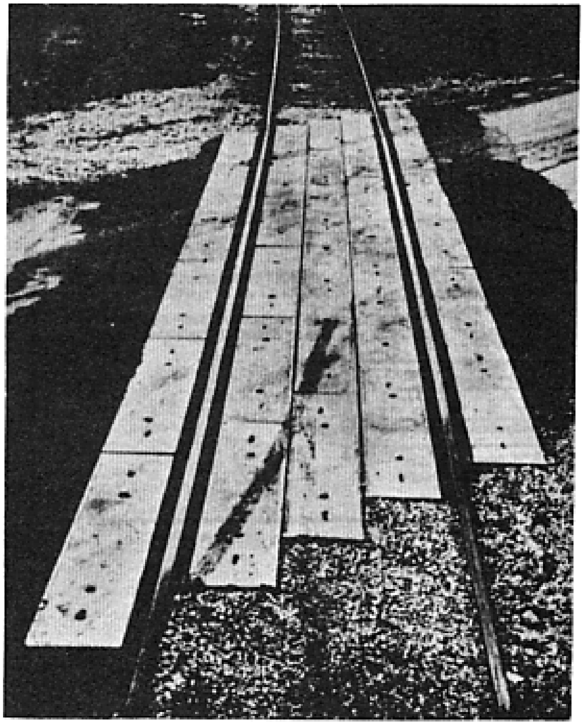


Figure 4–17. Precast concrete plank crossing.

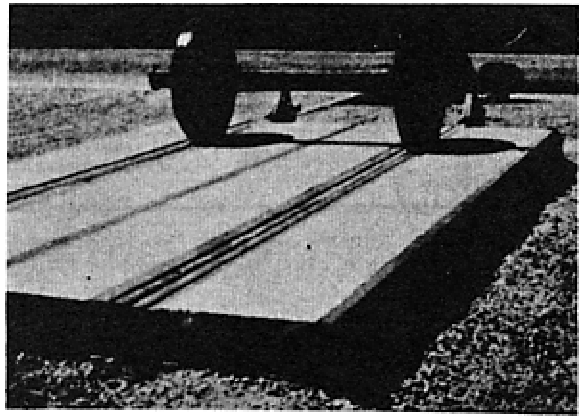


Figure 4–18. Precast concrete plank with rubber flangeway filler.

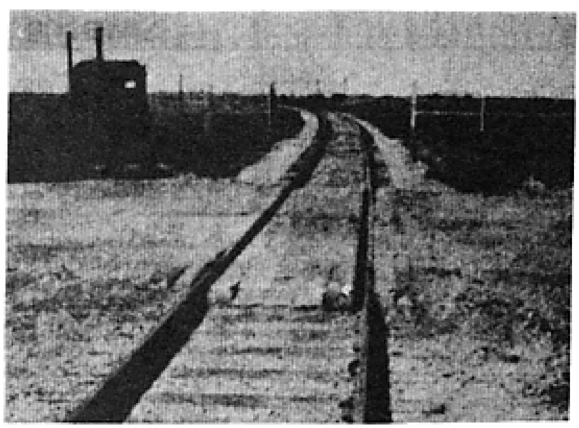


Figure 4–19. Timber crossing.

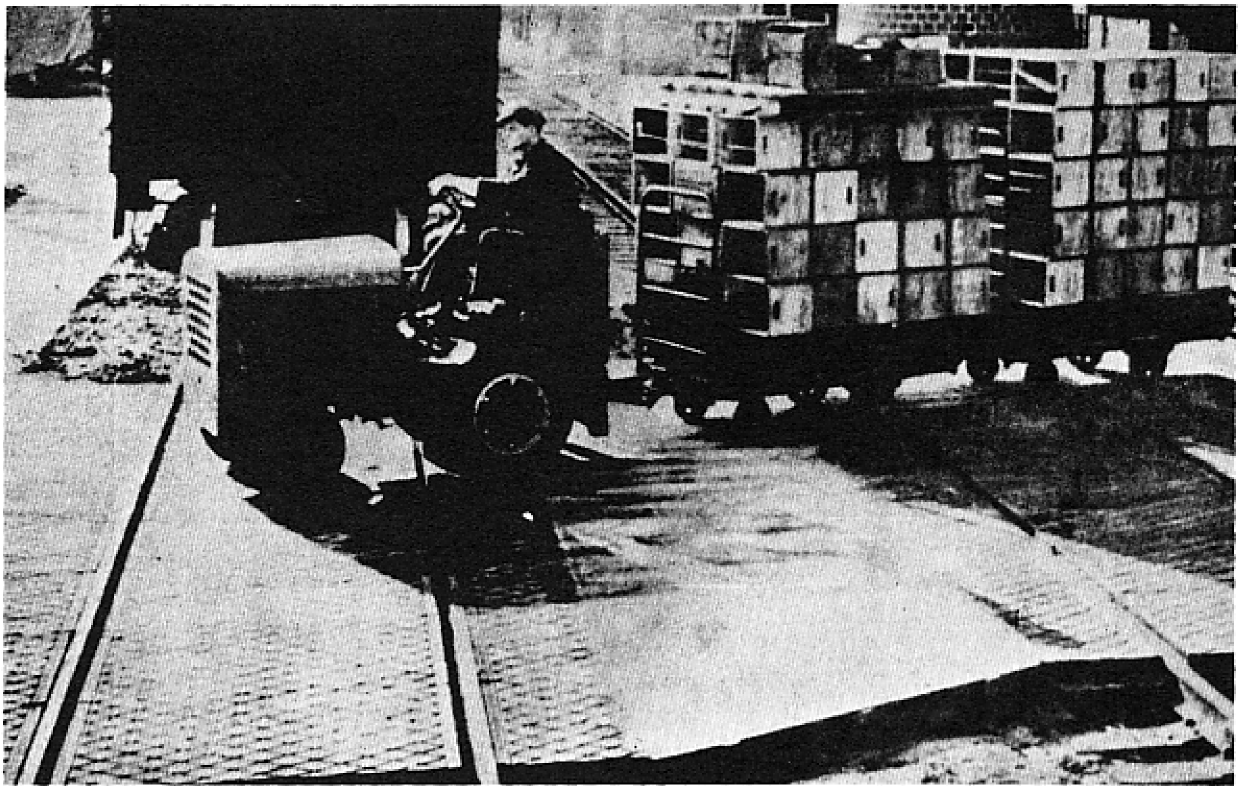


Figure 4-20. Rubber plank crossing.

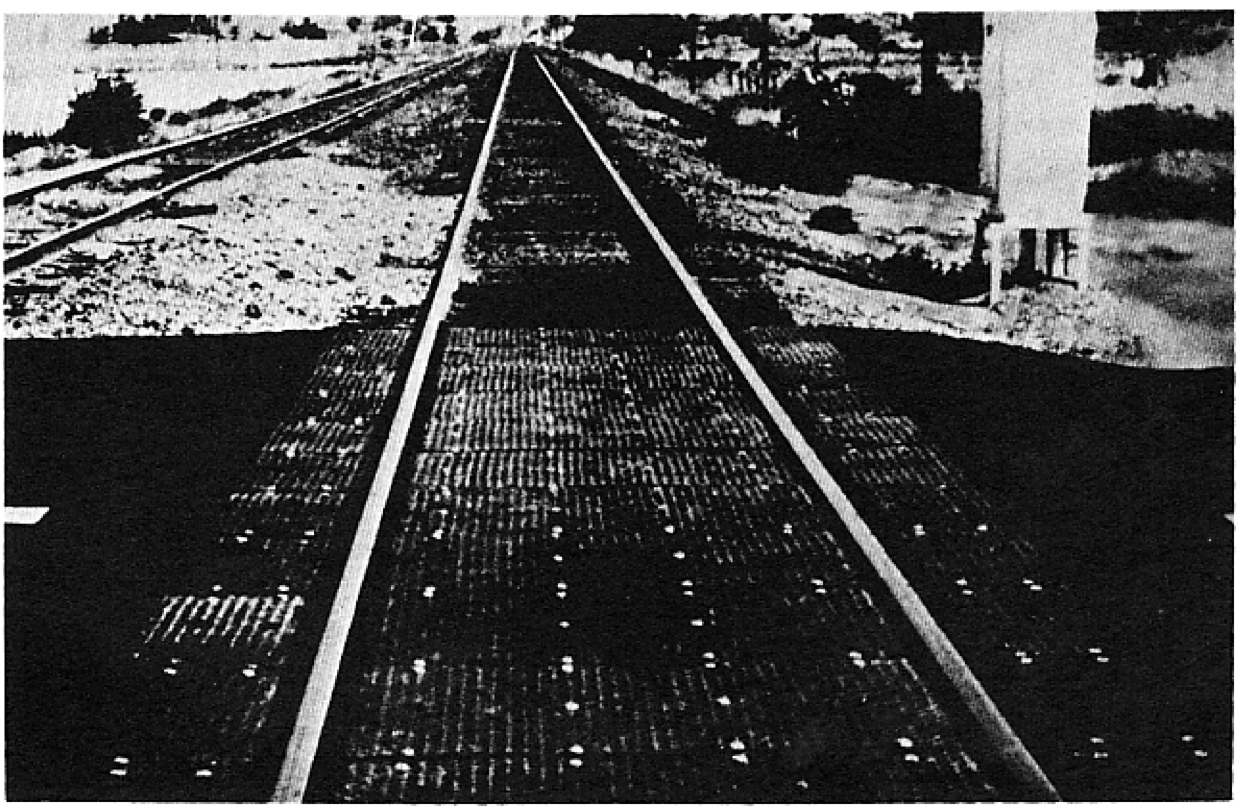


Figure 4-21. Modular plastic crossing.

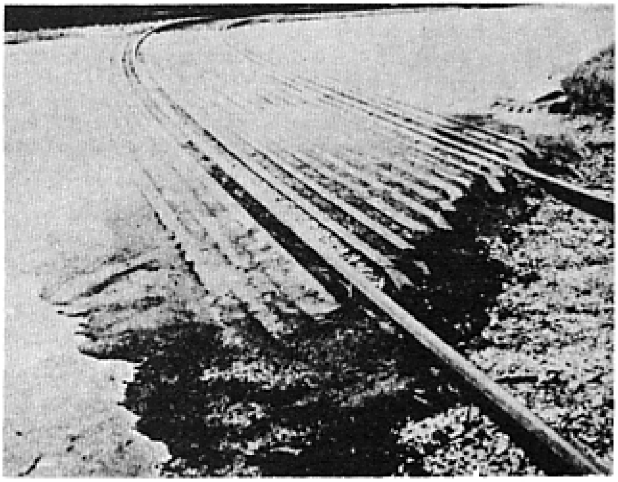


Figure 4–22. Used rail with asphalt filler.

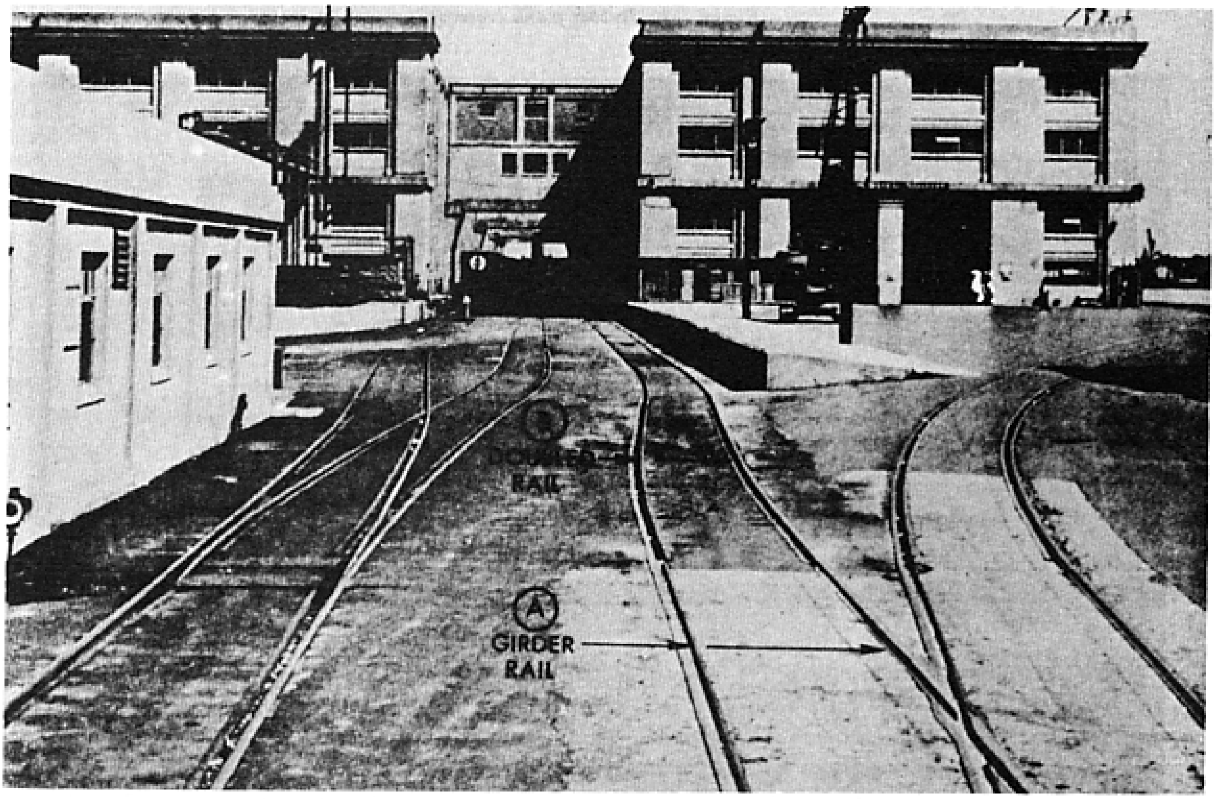


Figure 4–23. Trackage in paved area.

4-15. Signs and Signals.

Crossing sign and signal maintenance must be given a high priority to assure legibility and visibility.

4-15.1. Highway Crossing Signs and Signals. Standard highway-railway grade crossing signs are shown in Figure 4-24, a crossing signal in Figure 4-25, and location of signs and signals in Figure 4-26. For details of appropriate types of crossings and signals, see DOT Manual on Uniform Traffic Control Devices, Bulletin No. 6 of the Association of American Railroads (Railroad-Highway Grade Crossing Protection), and Chapter 9 of AREA Manual.

4.15.2. Maintenance of Signal Circuits. Electric and/or electromechanical signal inspection and maintenance should conform to AREA requirements and to manufacturer's recommendations. Circuit continuity checks, battery water level observations, trickle charger operating tests, relay point checks, light bulb tests, and related checks and inspections must be made periodically as specified or required by the installation's maintenance program or the serving railroad. Indicated defects must be corrected promptly.

4-15.3. Signal Cables. Signal cables are buried around main track switches and signal locations. Cables are buried at toe of ballast between instrument housing, switches and signals in the track circuit system territory, at interlocking plants, and at switches equipped with electric locks, as well as automatic block signal location. Maintenance employees working on roadbed at these locations should be informed by signal forces as to exact locations of these cables. Machine operators must exercise care to avoid damage to underground cables at these locations. In case of doubt as to location of cables, do not work digging machines within interlocking home signal limits.

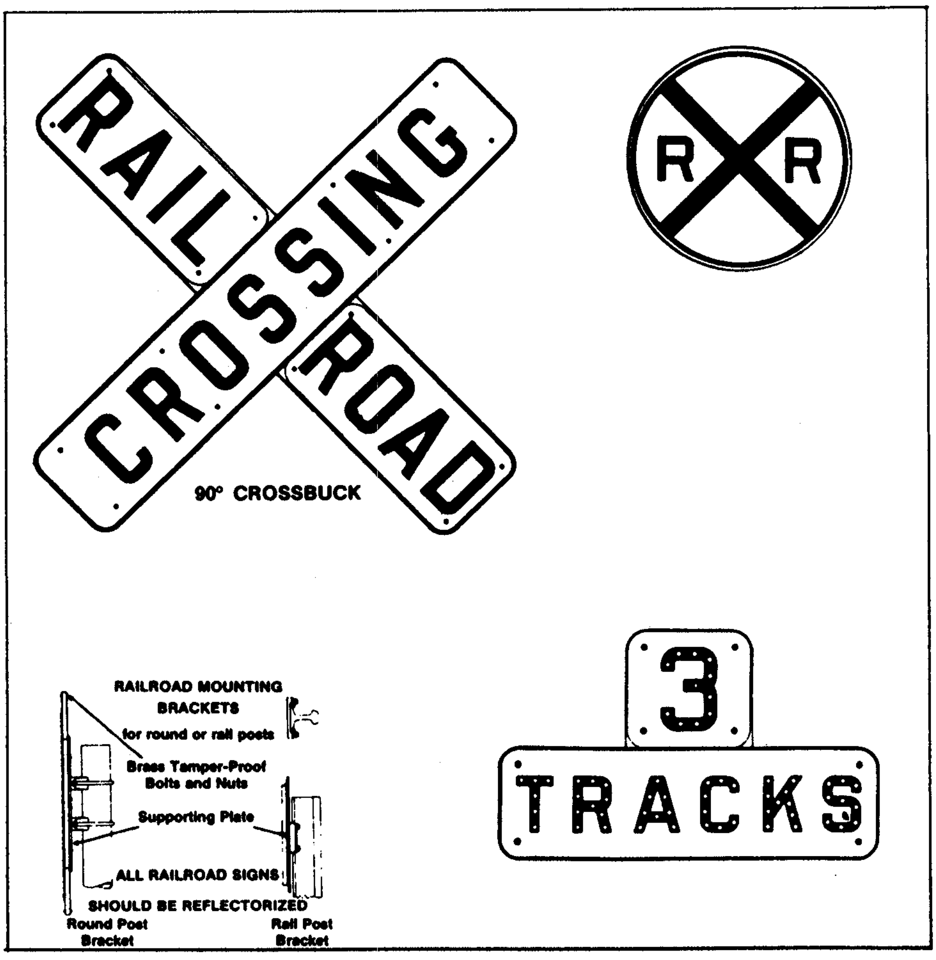


Figure 4-24. Typical grade crossing signs.

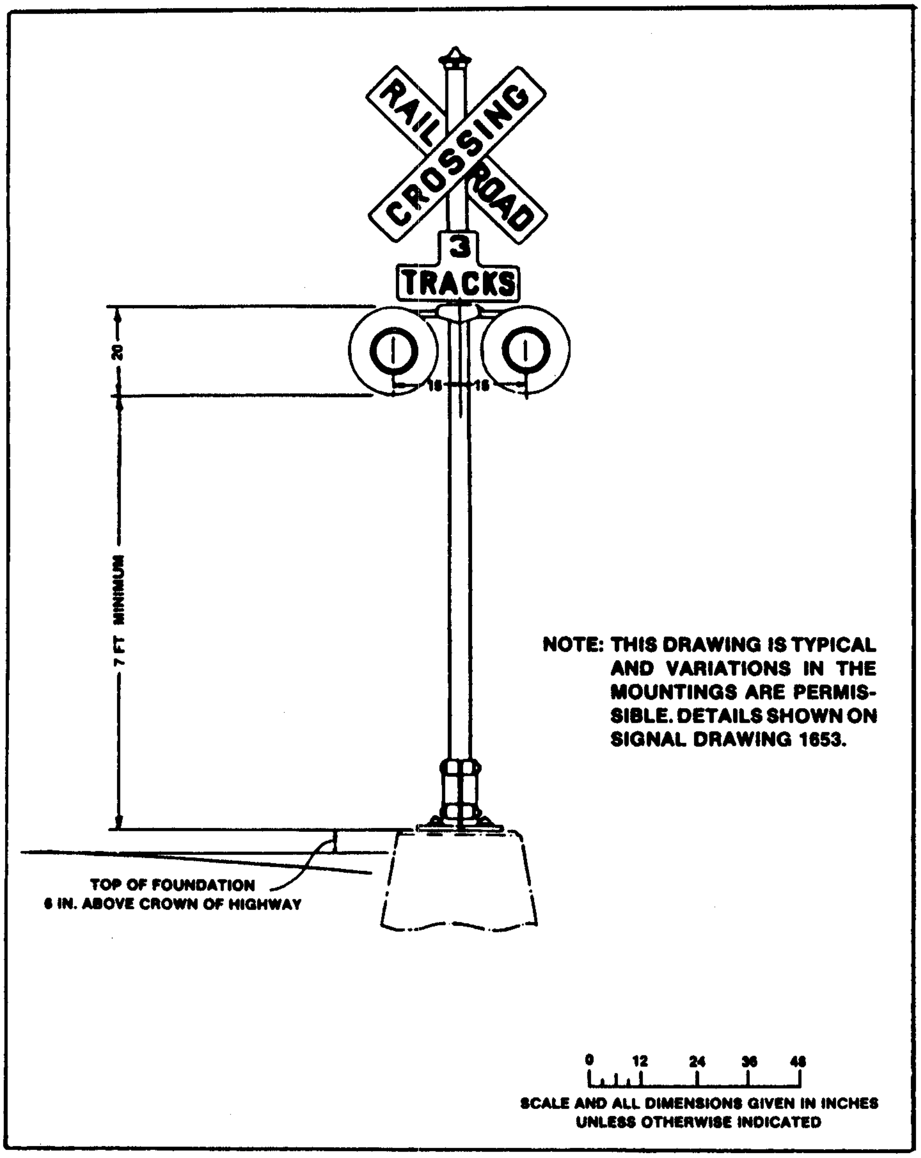


Figure 4-25. Highway crossing signal, flashing-light type with red signal sign.

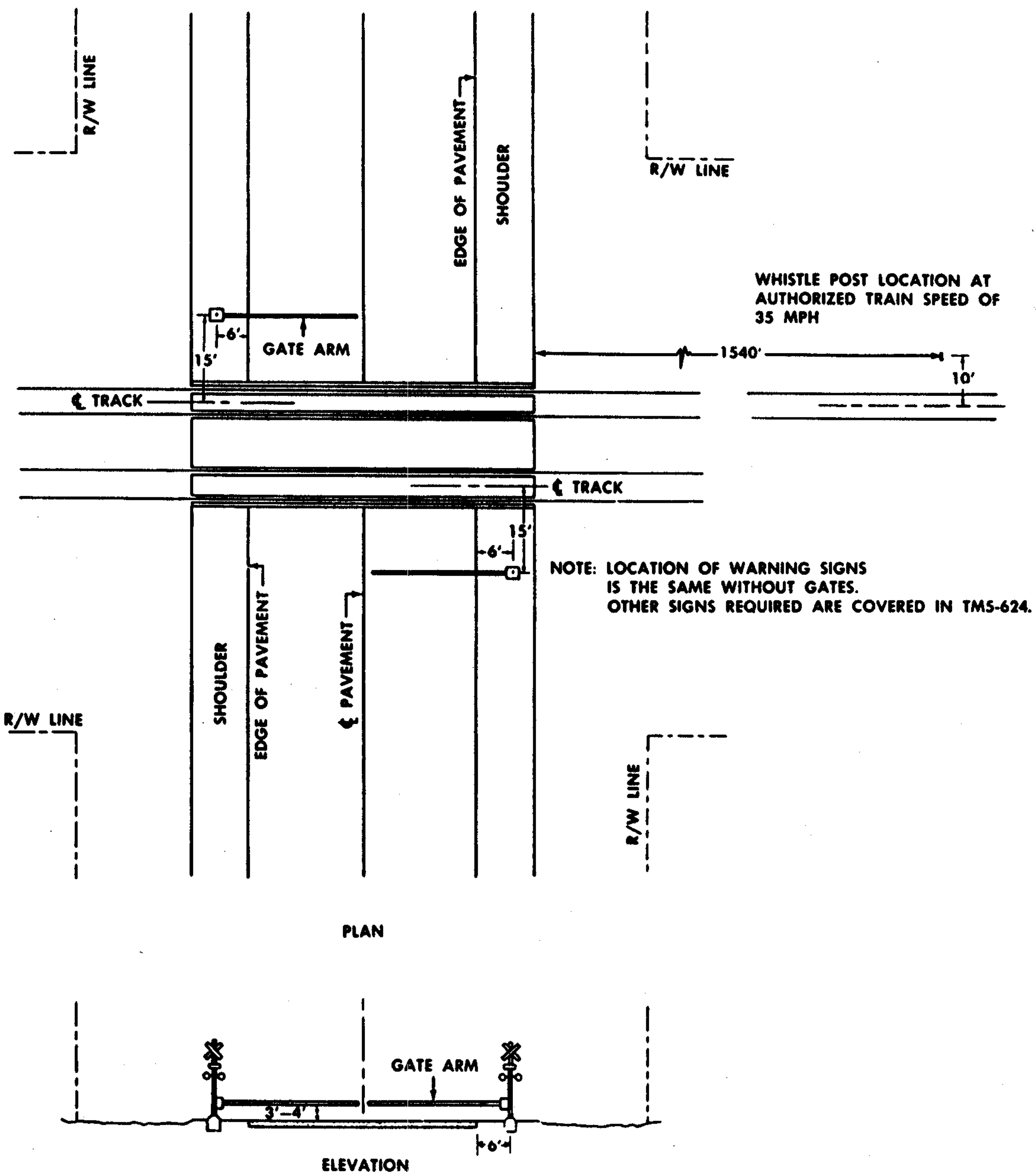


Figure 4-26. Location of warning signs and signals.

Section 3. MAINTENANCE OF ROADBED

4-16. General.

Good drainage is the most important single factor in roadbed maintenance. To provide maximum support for the track structure, subgrades should be kept as dry and stable as possible. Poor drainage not only affects the roadbed and the underlying earth structure (Figure 4-27) but also the side cuts and other track side areas. Where drainage deficiencies occur that cannot be corrected by normal maintenance practices, engineering assistance will be requested. Open ditches and pipe drains shall be maintained to function at maximum capacity. Weed control and efficient methods of ice control and snow removal are important factors in conjunction with water runoff. Inadequacies in the original drainage system shall be corrected as they become evident.

4-17. Inspection and Repair.

Alert, methodical, and timely inspection, with prompt correction of large and small defects, is necessary for the economical maintenance of drainage systems. The object is to preserve the original track and roadbed section by preventing obstructions that tend to divert or impede the flow in the drainage system. Emergency repairs to drainage systems must be made when conditions require such action, but a general program of repairing and cleaning should be conducted annually, preferably in the spring or after periods of unusual storms or rainy weather.

4-18. Subsurface Drainage.

Water falling on ballast soon soaks through to the subgrade. Impervious subgrade not properly graded so that the water will drain off to the side ditches will cause pools to form, which soften the subgrade, resulting in low spots in the summer and possible heaving in the winter. Poorly drained subgrades are reflected in poor track surface. Resurfacing or raising track instead of providing proper subdrainage is only a temporary measure. Slopes for drainage may vary from 1 inch in 2 feet to 1 inch in 5 feet. The only remedy to eliminate wet spots is to reshape the subgrade so that water will flow toward the ditches. Also, stabilization can be obtained by cement-subsurface grouting (Figure 4-28). If the trouble is localized in a very small area, subdrains may be used to drain off the excess water.

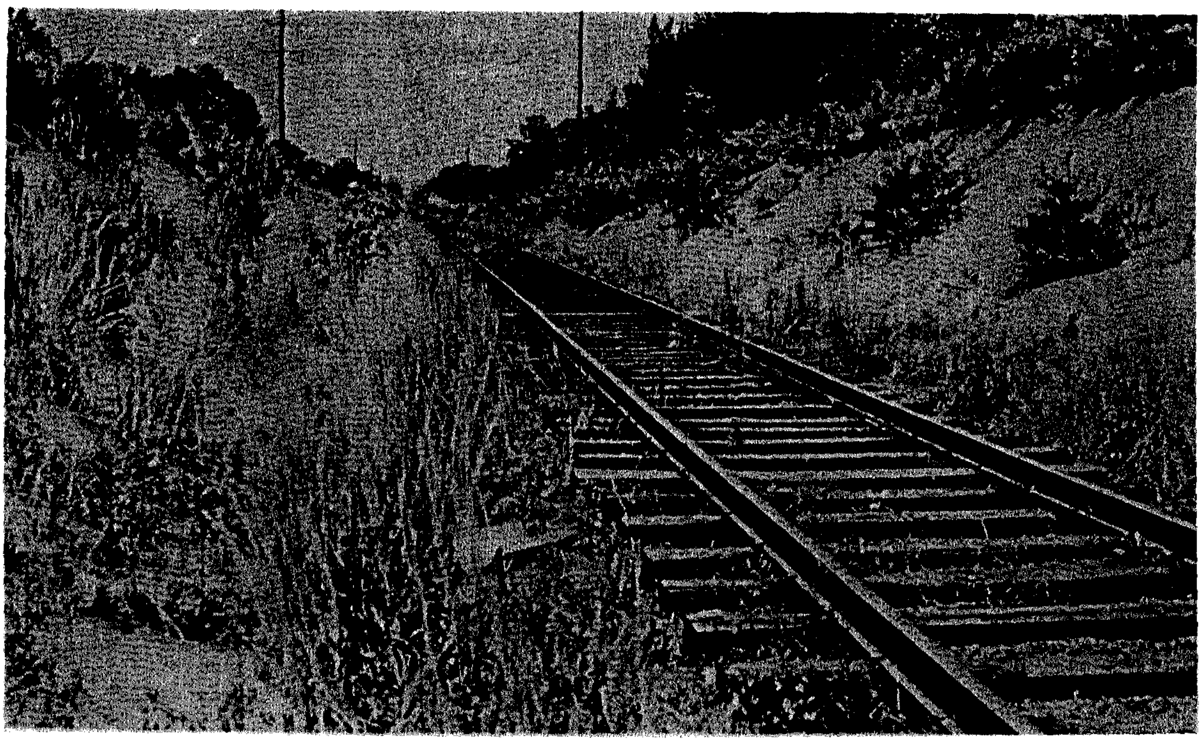


Figure 4-27. Ditches fouled by silt and vegetation.

Figure 4-28. Cement grouting soft roadbed.

4-19. Surface Drainage.

All surfaces must be sloped toward the drainage systems, and slopes maintained to minimize erosion during runoff. Drainage ditches and structures shall be kept in condition to dispose of runoff quickly. Obstructions that cause water to remain in pools shall be removed. Erosion of ditch sides and bottoms can be controlled by lining them with native grasses or by check dams, riprap, or pavement.

4-19.1. Ditch Maintenance. Where ditch maintenance is a constant problem because of faulty design or construction, permanent corrective measures may be required. For example, if the gradient is unsuitable, the ditch may scour (too steep) or may accumulate silt (too flat). Unchecked growth of vegetation (Figure 4-27) obstructs water flow and raises the water level in the ditch. This water can penetrate and soften the roadbed or restrict the drainage of the roadbed. Some soil wears away readily, and the slopes are eroded by rainfall and undermined by the flow of water in the ditch unless the gradient is correct and the streambed clear. Erosion of the ditch side slopes increases the silting in the ditch (Figure 4-29). Therefore, the side slopes must be stabilized or flattened to reduce erosion. Maintenance and repair measures must be determined to fit existing conditions.

4-19.2. Causes of Drainage Failure. Causes of failure have been mentioned generally in the preceding paragraphs. The following describe these causes in more detail.

4-19.2.1. Erosion. Erosion occurs when the velocity of the water or wind on the slope of an embankment or ditch causes the water to dislodge the soil from these areas and carry it away. The degree to which the velocity affects the ditch and side slopes depends upon the stability of the soil or the protection it has been given by additional stabilization. Loose, sandy, or silty soils are easily eroded at almost any velocity. Such soils must be stabilized by vegetative cover or often by riprap or concrete blankets. Riprap or concrete blankets have to extend sufficiently below the ditch bottom to prevent undermining. The most satisfctory solution to erosion control is to flatten the slope to reduce the velocity of the water to the rate that will keep erosion to a minimum and yet prevent unacceptable silting. This may require reconstruction, such as installing check dams or flattening the slope, that is beyond the scope of maintenance.

4-19.2.2. Lack of Drainage. When drainage is inadequate, unwanted water remains in the roadbed long enough to soften the subgrade. Dirty ballast can reduce the drainage of water as effectively as a stopped drain. Improperly shaped subgrade or pock-

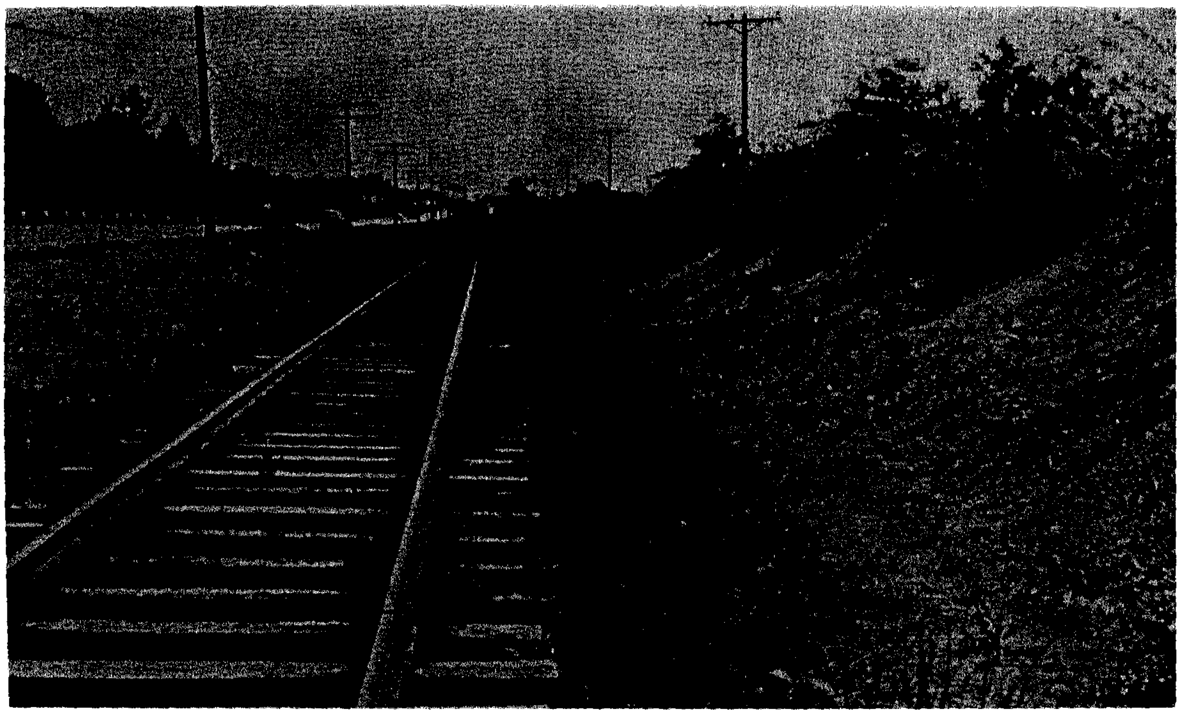


Figure 4-29. Erosion of side slopes.

ets that have developed in the subgrade can impound water to the detriment of the track system. Subdrains may become clogged, or the buildup of silt in the adjacent ditches will reduce the flow of water from beneath the track structure. Besides weakening the subgrade, trapped water during the winter can cause heaving. If this water freezes, it further retards the drainage which increases the problem (Figure 4-30).

4-19.3. Corrective Measures. Where it can be used effectively, offtrack power equipment gives more economical results for the cleaning of intercepting and drainage ditches than other methods. Handwork may be necessary where equipment is not available or where conditions prevent access of mechanical equipment. Ditching of ordinary material in side ditches in cuts may be subdivided into two principal classes, shallow cuts and deep cuts.

4-19.3.1. Shallow Cuts. Ditching in shallow cuts can be done with road graders that are equipped with blades for shaping ditches and slopes, by draglines, or under some conditions, by tractor-drawn scrapers. Such ditching shall not be done by hand where the magnitude of the work justifies the use of heavy equipment.

4-19.3.2. Deep Cuts. Where the volume of material to be removed is comparatively small, the work usually can be performed with graders. Handwork will not be resorted to unless a careful analysis shows the use of power equipment is not possible.

4-19.3.3. Use of Road Machinery. Where the volume of material to be removed is large, the cuts are long, or the points of disposal are remote, the use of power ditchers or other heavy excavating machinery is justified whenever it is available. For example, if the terrain is such that draglines can work along the top of the cut, comparatively deep cuts can be cleaned quickly, at less expense than by other methods, and with no interruption of railroad transportation. Power scrapers or trucks and power shovels may be the most practical machinery to use.

4-19.3.4. Use of Car-Mounted Machinery. Where the depth of the cut, the desire to use the excavated material, or other conditions justify, power-operated ditchers or draglines mounted on cars are effective. A work train is necessary, and the usual arrangement is to place the ditcher or dragline between two air-dump cars. Before using work trains and on-track equipment, a very careful analysis shall be made of the situation to see whether the cleaning can be done satisfactorily by methods not affecting train movements. Where the personnel and equipment capability of the organization are not adequate to perform extensive maintenance, repair, or rehabilitation of railroad trackage, consideration shall be given to the use of contractual services.

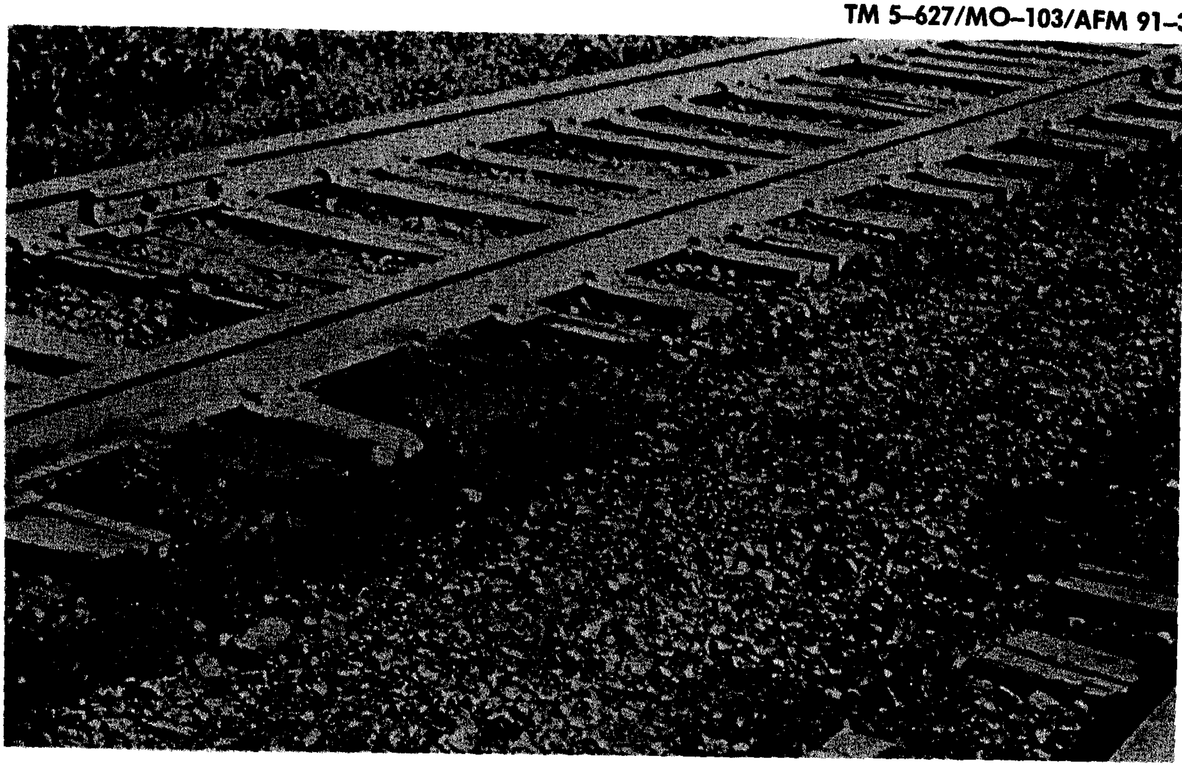


Figure 4-30. Inadequately drained roadbed.

4-19.3.5. Disposing of Surplus Earth Material. In all cases, waste material should be disposed of so it will not wash back into the cut. Material removed from side ditches shall never be cast on the adjacent slope. When waste dirt is disposed of along embankments, it should be deposited at an elevation below the bottom of the ballast.

4-20. Storm Pipe Drains.

A regular program of maintenance of pipe drains should be conducted. As-built record plans must be kept current regarding changes in the system. Limits of covered drain shall be marked with adequate signs to facilitate inspection and maintenance.

4-20.1. Routine Maintenance.

4-20.1.1. Outlet Ditches. Ditches leading from outlet pipes shall be kep clean, with adequate width, depth, and grade to insure proper drainage. Side banks should be maintained with sufficient slope that the material involved will not slide. Ditches should be maintained free of vegetation, debris, and other obstructions. Irregularities in alignment and grade tend to cause silting and scouring and should be avoided.

4-20.1.2. Outlet Pipes. Screens on outlet pipes shall be kept in place to prevent small animals from entering pipes. When silting occurs at the outlet, screens shall be removed and the opening cleaned. Special care should be given outlets to make certain that stoppage does not occur.

4-20.1.2.1. Overflow. Occasionally, drainage pipes discharging near bridges and culverts are subject to overflow or backwater during high water. Inspection should be made as soon as water recedes, and if necessary the pipe drainage system flushed.

4-20.1.2.2. Inspection. Frequent inspection of the mains shall be made through the risers. Any tendency to silt must be carefully watched, and, when it occurs to a marked degree, the entire system of mains should be flushed with water from a water car or other convenient supply. This is especially necessary for systems involving near level grades.

4-20.1.2.3. Vegetation. Trees, bushes, or vegetation with deep roots shall not be allowed to grow near any line of subsurface drainpipe. The roots, seeking water, may fill the pipes and cause stoppage in the system.

4-20.2. Correcting Failures. Rapid silting of main drains indicates an obstruction, a level spot, or reverse grade, which must be located and corrected. In excavating for obstructions, care shall be exercised to prevent fouling the drains. The excavation should be backfilled with permeable material similar to that specified in the original design. Any tendency toward further development of water pockets or soft spots and heaving must be studied, and test holes dug to detemine the direct cause of failure. If failure caused by a defect in the pipe drains occurs, immediate repairs shall be made. If heaving is caused by obstinate water pockets or soft spots that are not tapped with laterals, laterals should be installed.

4-21. Soft Spots and Water Pockets.

4-21.1. General. Soft spots and water pockets exist in localities where soil conditions are unfavorable to satisfactory maintenance, particularly in clay. They will be found in both fills and cuts, but more generally in clay cuts. In soft spots the ballast generally has settled into the roadbed, forming a trough or pockets under the track. This condition usually causes the subballast and roadbed to be pushed out laterally and oftentimes raised (see Figures 4-31 and 4-32), thus forming walls that prevent the water draining from the track. This condition invariably results in water pockets. The usual methods of surfacing and tamping track have no permanent effect in correcting soft spots and water pockets. Soft spots and water pockets shall be given prompt attention because they soon develop into a serious defect. The longer they exist, the more hazardous they become, and the greater the resulting maintenance expense or time and cost involved in providing a permanent remedy.

4-21.2. Corrective Measures. In minor areas of soft spots oı water pockets, the maintenance crew may take corrective action by increasing drain fields. However, in addition to pipe drains, various new methods of stabilizing soft spots and water pockets have been developed, such as roadbed grouting, the driving of poles or ties, and the use of sandpiles. In severe cases the situation should be studied by the engineers to see which method will probably give the most economical and satisfactory results.

4-21.2.1. Pipe Drain Method. Test holes shall be made at intervals frequent enough to determine accurately the profile of the bottom of the water pockets. Lateral drains shall be spaced so as to tap all the pockets; 16 feet center to center will usually suffice. The main and laterals shall be placed in stable material, with the minimum depth of the main 24 inches, and of the lateral 12 inches below the bottom of the deepest pocket, unless the surface of solid rock or hard shale lies at a lesser depth; in this case, the minimum depth of the main can be reduced to 12 inches below the bottom of the deepest pocket. Quite often the "softest" cuts are of a clay material overlying rock or shale. Usually this harder underlying stratum is not on a uniform plane, but is irregular, and if it is uniform it will not conform with the grade of the main. To prevent dislocation of the drainpipe, it is well to place the pipe into the rock or shale to a depth at least equal to the diameter of the pipe.

4-21.2.2. Grouting.

4-21.2.2.1. Principle. As has been described previously, water pockets are caused by ballast being driven into the subgrade due to traffic passing over the rails. After the ballast has been driven into the subgrade (impervious soils), heaving occurs along the shoulder of the roadbed. This heaving material is an earth slurry created by the action of traffic vibrating the ballast against the grade, thus mixing earth and water and forcing it out at the toe of the ballast section. As a rule, free water is indicated below the area under vibration. The grouting method for curing this condition consists of pumping a concrete slurry into the void in the subgrade. The grout is pumped into place until the void is filled and its pressure has raised the roadbed back to the desired elevation. It is possible to determine that the void (water pocket) is

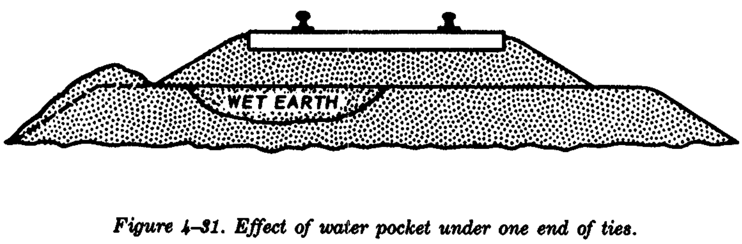


Figure 4-31. Effect of water pocket under one end of ties.

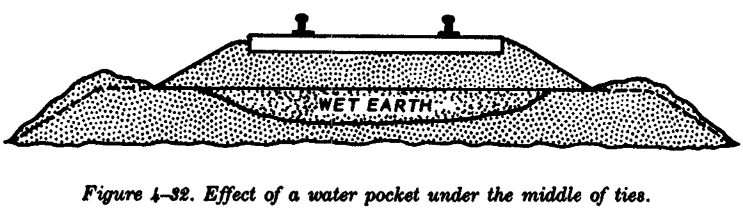


Figure 4-32. Effect of a water pocket under the middle of ties.

filled by observing leakage of the grout up through the surface or along the fill section. The grout consists of a very find sand and enough cement to provide a partial set of the slurry (a rigid concrete base is not desirable). Immediately following the grouting, the track should be checked for elevation and lined out-of-face.

4-21.2.2.2. Machinery and Equipment. If grouting is necessary and grouting equipment is not available at the installation, the equipment used in pavement mudjacking and undersealing is suitable for railroad grouting.

4-21.2.2.3. Other Material. Under certain conditions, bituminous materials may also be used for subsurface sealing. The methods for placing are similar to those for cement grout slurry.

4-22. Slides.

4.22.1. General. Slides usually occur in unconsolidated material, but may occur in open faces of rock formations. Gravity is a primary cause, supplemented by lubricating water; undermining (natural or artificial); clay-type material; certain types of geological structure; increase of load; and, in the case of rock slides specifically, by joint planes; fault planes; schistose structure; or strata dipping toward an open face. In the latter cases, slides are often accentuated by clay seams in partings of the rock. Where embankments are subjected to hydrostaic head for a length of time sufficient to saturate the embankment, slides may occur suddenly and without warning, particularly if the material is distrubed, as by spreading operations.

4-22.2. Corrective Measures. Each slide shall be considered an individual problem. The cause of the slide should be determined by thorough and expert examination, under the direction of an engineer, of the soils, drainage conditions, and geological conditions related to the slide. The prevalence of unstable material will be ascertained in order to arive at a decision as to economic preference between the removal of sliding material and the application of suitable control methods. The removal or prevention of the cause of a slide is as important as the restoration of the roadway.

4-22.2.1. Piles or Retaining Walls. Piles or retaining walls for the prevention or correction of slides may be used based on engineering evaluation.

4-22.2.2. Diversion of Surface Water. Surface water must be intercepted and diverted by surface ditches.

4-22.2.3. Drains. Underground water must be drained away, or intercepted at its underground source, and diverted. Slides caused by the flow of underlying material often may be controlled by constructing subsurface drains containing perforated pipe and draining around the toe of the slide. When this unstable underlying material is deep, tunneling to intercept the flow may be necessary. When feasible, water cutoff is usually more economical and effective than trenching or tunneling. Subsurface drains with perforated pipe are sometimes necessary to remove underground water from the slide itself when it is impractical to remove all the sliding material in hillside or cut slides. This control method is usually coupled with removal of sliding material, slope modification, and water cutoff, or intercepting drainage.

4-22.2.4. Terracing. Terracing or benching the slope lightens the load and may lessen or prevent sliding. This may be done in addition to using other methods of control. The removal of the entire moving mass in hillside or cut slides may be more economical than control methods.

4-22.2.5. Compacted Berms. Firmly compacted berms, approximately one-third the height of the fill, will help stabilize the fill and may be used in connection with drainage control methods. Weighting of the toe of a slide is useless if movement exists throughout the mass. When used, the weight must rest upon or be carried down to solid material.

4-23. Frost Heave.

4-23.1. General. When water collects unevenly under the track and expands because of freezing, the track is lifted above the wet spots and produces what is known as "heaved track" (Figures 4-31 and 4-32). The extent of heaving caused by frost action depends on the character and condition of material in the ballast and subgrade, the amount of moisture retained, and the extent and duration of low temperatures.

4-23.2. Corrective Measures. Maintaining shimmed track is costly in maintenance time, and the repeated spiking of ties due to placing and adjusting shims and braces reduces the service life of the ties. However, such maintenance may be necessary until permanent corrective action can be taken. Careful study and considerable work and expenditure are warranted for protection against trackage heave caused by frost action.

4-23.2.1. Drainage. On existing tracks, proper drainage is the principal factor in eliminating and heaving of track.

4-23.2.2. Isolated Cases. Where heaving occurs in isolated places on fills, much may be accomplished by digging out the soft areas of the subgrade to a depth of 2 feet or more and carrying the excavation to the shoulder to afford proper drainage and so decrease the tendency to form water pockets. The excavation should be backfilled with clean coarse gravel or similar material and an adequate depth of good ballast applied.

4-23.2.3. Underdrains. In wet cuts, the installation of perforated underdrains backfilled with porous material provides excellent results.

4-23.2.4. Subgrade. If the subgrade obstructs drainage of the ballast section, it will be graded off and replaced with permeable material to the depth necessary to correct the condition.

4-23.2.5. Shoulders. In some cases where the embankment is built of impervious material, grading the shoulder off the ends of the ties and to a depth of 3 or 4 feet and replacing it with pervious material may be justified. Before undertaking such a project, careful exploration must be made to assure that the wet spots will be drained. Where depressions exist in the roadbed, free drainage to the shoulders must be assured before this method will function.

4-23.2.6. Stabilization. Cement or soil slurry (Figure 4-28) or bituminous subsealing may be used to permanently stabilize roadbed areas subject to freezing where heaving is extensive and the expenditure is justified. Installation of membrane materials may be considered in special cases. Traffic loads, frequency of use, and dependence of the installation on its railroad facility must be considered, as well as availability of maintenance crewmen and equipment to do the work.

4-24. Drainage of Yard Tracks.

Railraod yards are usually located on fairly flat terrain and require special drainage treatment. Because large, open ditches in railroad yards are objectionable, pipe storm drains and subdrains are required unless natural soils are particularly suitable for self draining. Periodic inspections, rodding, and cleaning of installed drainage systems are necessary if they are to function satisfactorily. As conditions change at a given installation and additional facilities are added, or as clearing and building of adjacent areas increase the water shed of the area, it may be necessary to adjust subsurface and runoff facilities at yards.

4-25. Vegetation Control.

The elimination of vegetation from areas where it is not required for erosion control is essential to economical maintenance of tracks, as well as to the appearance of the roadway. Vegetation should be controlled or eliminated to at least the limits of the ballast section to minimize the danger of firs. Proper visibility of traffic signals must be maintained. Dirty ballast permits the growth of weeds that interfere with drainage and shorten the life of ties. The remedy is to clean the ballast. Use approved herbicides to eliminate vegetation from ballast and other areas of the roadway. Consult a specialist in this field for the best material and method to use. Weeds along the roadway can be controlled by mowing, burning, or by using herbicides. **NOTE:** It is mandatory that personnel handling herbicides be certified.

4-26. Snow and Ice Control.

Snowfall in amounts sufficient to obstruct railroad traffic or hinder operations can be expected at northern installations. Ice and packed snow can be a problem at crossings and in industrial areas where the tracks are in the pavement.

4-26.1. Snow Plan. A snow plan should be prepared in advance of the snow season in conjunction with the snow plan for installation roads. The plan must contain data on materials, manpower, and procedures to be used under varying storm conditions.

4-26.2. Snow Fences. Snow fences keep snow from drifting onto the roadbed in localities where heavy snowstorms are frequent. Effective placement of snow fences can be assured by keeping records of locations where drifts have occurred during the winter season.

4-26.3. Snow and Ice Removal. Snow and ice will be removed promptly from switches, frogs, guardrails, and flangeways at highway crossings. Also, snow and ice will be removed promptly from loading platforms, track scales, turntables or transfer tables, and from any other places where personnel or property may be endangered.

4-26.4. Chemical Control. Snow and ice control chemicals, sodium chloride (salt), calcium chloride, and urea are effective in melting ice and packed snow. The lowest temperatures at which these chemicals are effective under field conditions are: urea, +25°F (-4°C); and calcium chloride, -20°F (-29°C).

4-26.5. Snow-Melting Heaters. Snow-burning cans may be used to advantage. At switches where serious snow and ice conditions are expected over long periods, snow-melting pots or switch heaters may be used. Electrical switch heaters are not recommended because of the high operating cost.

4-27. Roadway Cleanup.

During surfacing, lining, gaging operations, and the like, all deficiencies noted should be corrected each working day. The shoulder line must be clearly defined, berms cleaned or raked, and drainage ditches cleaned. All scrap metal shall be collected and taken to a designated storage place. Old ties unfit for further track use or for cribbing shall be disposed of by burial in landfill or by another method of disposal that does not conflict with pollution laws. All rubbish and waste must be cleared from the work, and the entire right-of-way left in a safe and workmanlike condition.